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Meteorology

Chalcel Cooperation and Chemical Interactions
PROFILES OF TRACE REACTIVE SPECIES IN THE UNPOLLUTED
SURFACE LAYER

atomorpheric Remarchs, P.O. Box 3000, Boulder, Colorado 80307;

Me have lowestigated agreest appects of trace gam philochemistry in the marine boundary layer using a rime-dependent transport—linetics coded with one-disonal sonal coder diffusion. The photochemical achases in the model [tho-open and Clearons, 1942] is represented by a conventional completent of reactions involving 0, M. H and unthane-derived organic species; boundary conditions are assigned which give low earlace as in in ratios of 0; and 100, [Powthler et al., 1950] McFariand of al., 1992] characteristic of the resorte perime environment. Altitude dependent oddy diffusion coefficients in the surface layer flux - 100 on are based on the lowestethous desirance layer. Diffusion coefficients in the surface layer are taken iron table and burran [1976]. The surface is nessured to be the tropical ocean with a steady-market pixel layer. In the simulations of any layer the sixed layer.

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A. Arting (Gadged Laboratory for Atmospheric Sciences, NASA/Godderd tower I) ght Center, Grownbut, Naryland, 2011), S. Vemury
An enalysis of the first year of the himbus 7 arch hedisinon Bedgent data sal reveals that there are systematic differences between wide and narrow (1914 of view measurements. The larger differences appear in She slobed date and are due primarily to a hims introduced by the processing method. There are smaller differences, associated with the outgoing localitation, which are probably due to errors in Control of the Contro

Vol. 65, No. 12, Pages 105 - 112

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This map indicates the george of relationships among the yearst them the Rio Grande Riti and Adjac he ond Basin and Bange Route

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Geologic map of the Rio Grande Rill and Southeastern Colorado Platenu, New Mexica, and Arizona (1983) by W. S. Baidridge, Y. Bartov, and A Red

> TABLE 1. Methods of Data Compression and Expected Improvement Factors

kb s~i Method Standard (12-bit A-D) Logarithmic A-D Difference coding Delta modulation Adaptive delta modu-Subband coding Transform.coding

Seismometer

Technology William A. Prothero, Jr. Department of Geological Sciences University of California

Ocean Bottom

Seismometers have been placed on the ocean bottom for about 45 years, beginning with the work of Ewing and Vine [1938], and their current use to measure signals from earthquakes and explosions constitutes an im portant research method for seismological studies. Approximately 20 research groups are artive in the United Kingdom, France, West Germany, Japan, Canada, and the Uniced States. A review of ocean bottom seismoni cter (OBS) instrument characteristics and OBS scientific studies may be found in Whitmarth and Librall [1984]. OBS instrumentation is also important for land seismology. The recording systems that have been developed have been generally more suphistirated than those available for land use, and several modern land seismic recording systems are

Sama Barbara, CA (13106

based on OBS rerording system designs. The instrumentation developed for OBS work was the topic of a occuring held at the University of California, Santa Barbara, in July 1982. This arriele will disruss the state of the art of OBS Terhnology, some of the problems remaining to be solved, and some of the solutions proposed and implemented by OBS scientists and engineers. It is not intended as a comprehensive review of existing instrume oranion.

The requirements for OBS rapsules are similar to those for space satellites. They must be self comained, have a recovery methed, and, usually, a communication system between the ship and the instrument. Reliability is a troublesoine problem. Shipboard rheckout, repair, and deployment utust be stream-lined as much as possible since multiple inurument deployments must be accomplished under often adverse conditions.

The typical OBS consists of a honyant instrament rapside which is held on the bottom by some kind of anchor. It is deployed by dropping it over the side all a ship, whereup-on it free-falls to the bontom. The electronics systems which log data, release the anchor, and rommunicate to the surface acoustically are contained within the pressure case. Both seimomerers and hydrophones may be used as sensors. The coupling to the bottom is through the anchor, but schemes have been developed to separate seismometers from the main instrument case in order to improve the coupling to the bottom and reduce the coupling of vibrations hetween the tape recorder and seisometer(s). When it is time to retrieve die OBS, the anchor is separated from the buoyam instrument case using no explosive boh, electrolytically dissolving wire, or mechanical acutatur. The instrument case then floats to the surface, where it is rettieved. The following sections will describe each aspect of various OBS in more detail.

OBS Pressure Container

80th tubes and spheres have been used as pressure comminers. A pressure sphere has the advantage of being huoyam, requiring ne extra flotation. The use of Benthus 36-cm glass spheres to contain the instrumentation was pioneered for OBS by Latham et al. [1978]. Kasahara et al. [1979] have also designed an instrument using a Bemhos glass sphere. Glass spheres are particularly useful for simpler, less expensive instruments which can be made to fit inside. It is impressive to see them being deployed since they can be handled by two persons (without a crane) and are very easy to deploy from large or small ressels. Care must be exercised with shipboard radio equipment since the glass conisolate agains) electrical inte ference, which was a problem during the Rivera Ocean Seismie Experiment (ROSE) for University of Texas, Galveston, scientists. An-Other problem with using glass spheres is the loss rate, which seems to be at about 10%, resumably due to sphere failure at depth. For an inexpensive recording package, how-

> Improve-Factors Adaptive predictive coding

ever, the operational advantages of glass spheres are impressive.

Figure I shows an OBS using a mbe [Mattaboni and Solomon, 1977]. It uses a 24.1-cm ID tube with a 2.5-cm wall thickness. The external sensor package will be discussed later. Tubes with 15.24 rm ID (6 in.) are more commonly used in physical oreanographic applications and are also used in O85 capsules. Figure 2 shows a design using multiple tubes of this size [Prothero, 1979]. Wires connecting the tithes are routed through a common baseplate. The use of tubes for the pressure rase has some advantages over spheres. The tube length is variable so that space can be made for finure upgrades without a complete redesign of the parkage; a sphere is much more difficult to enlarge. Tubes with flat endraps provide good surfaces for hydrophones and test conneriors, and the interior electronirs rao he removed more easily for cherkout.

ay deployment.

buffer which run hold the emire event of in-

terest will be necessary, or contamination of

Prothero and Scharcher [1981] described

are amplified through thers and a gain-rang-

ing amplifier with three 18-dB gain steps, The gain is reduced by a hardware threshold

detertor and reset to its maximum value by

changes to follow the signal or to be left con-

stant throughout the thiration of the event.

microprocessor, which executes the histruc-

The system is controlled by an 1M0100 12-bit

tion set of the PDP-8 minicromputer. Record-

The cassene recorder has the disadvantage of

not observably shake the seismometers when

it runs. All triggering, gain setting, acoustic

low data capacity, but it is very quiet and does

ing is done on a Braemar cassene recorder

with capacity of 1.8 Mb on a C90 cassette.

computer ronnmant. This enables gain

the data must be accepted.

They are also much less expensive than spheres. The sphere cases are more difficult to disassemble, since the hemispheres are heavy and difficult to hold on to. Handles are usually not installed on spheres, to reduce rorrosion at the attachment points. Portable shipboard labs have been sperially designed to make this less difficult [Prothero, 1976]. A spherical design has a major advantage, how-ever: External flotation is not needed, and this will make it easier to acoid vibrational modes which will distort the signal to be measured. Also, larger components such as sen-sors and recorders will fit into the sphere bin may not fit into the smaller tube instruments.

Acoustic Transponders and Communication

For arcurate location of capstiles and communication of diagnostic information between the deployed OBS and a surface ship, an aconstic communication system is very useful. The use of acoustic communication was pioneered for free-drop capsules by Sundgruss [1968]. Since then, they are commonly incorporared in O8S capsules [e.g., Prothero, 1974; Koelsch and Purdy, 1979]. Actuasic communication allows the location of the instrument to be determined to an accuracy of several meters relative to the ship's position. Inversion terliniques for optimally locating an attay of instruments relative to a ship receiving satellite mayigation information have been developed [see Creages and Dorman, 1989] Absoline insumment beations can be determined to 20-30 m. by this reclinique. Flexible instrument rerovery times can save expensive shiptime, and allow nonfunctioning instittments to be recovered and redeployed. Simple, manually decodable diagnostic codes allow status information such as ground noise level, tape crusumption, and number of trig-gers to be determined before the instrument is left for a long experiment. Protheto [1979] also uses the acoustic system to determine in sim OBS clork corrections accurate to several

Commercial acoustic systems in use by various groups are manufartured by Sonatech Carp. [Prothero, 1979; Prothero, 1974], A.M.F. [Koelsch and Furdy 1979; Koelsch et al., 1982]. Benthos Corp. [Ambuter and Davu, 1981], an Inter-Ocean Corp. rebuild [Moore et al., 1981], and are homebuilt [Tucker, 1969]. A new, self-romained acoustic release and transponder of extremely small size (12-cm diameter by 51-rn) length) was described by H. Murakami [Nagumo et al., 1981]. It uses frequency on between two carrier frequencies of 11.0 amd 10.5 kHz to encode the commands and has successfully been used in di-rect distances up to 8 km from the surface

Data Logging Systems

The design of OBS data recording elec-tronics has been dominated by the dynamic range and storage requirements, which are severe for seismic data. A typical earthquake experiment with an OBS might require a bandwidth of 50 Hz and a recording time of 1 month. For digital data, this would require more than 2.5 x 10s samples for each componeut recorded. Analog sape recorders have been built which run very slowly and record for 1 month on large reels [e.g., Johnson, R. V., et al., 1977]. An important limitation of analog recording is the dynamic range, which is less than 40 dB in the direct write mode. Schemes where various gain channels are employed Improve the situation, but the fundamental dynamic range problem exists.

Earthquake experiments place the most stringent requirements on dynamic range of the recording system. If magnitude 0 to 6 earthquakes are to be recorded without saturadon, a range of more than 6 orders of magnitude must be recorded. However, a particular event can be adequately recorded using just 12 bits (1:4096 resolution) of data as long as the peak signal is onscale. Gain-ranging amplifiers provide a solution to this problem. D. Koelsch (Figure 8) reported on a new ocean bottom hydrophone capsule which implements gain ranging in five 12 dB gain

diagnostics, and data arquisition are consteps [Koelsch et al., 1982]. The block diagram shows that the system includes an RCA COScrolled by the inicroproressor. Modifications MAC 1802 microprocessor for system control to the original microearthquake instrument and a DC-300 cartridge tape recorder with to allow for teleseismic recording include adding a third tube, rhanging the seismome-17.3 Mb (megabytes; I byte = 8 bits) of data capacity. This system is capable of sampling ters, amplifiers, anti-alias filters, and some to 1500 Hz widi a 12-bit A-D converter, and new software. The rather minimal hardware 10 8500 Hz with an 8-bit A-D. It stores data changes needed to produce this significant in a 53,248-byte semiconductor buffer before rhange in function of the instrument attests writes it to the tape recorder. Capacity for to the flexibility of a microprocessor-based future expansion is provided by using dual data logging system. The entire triggering port memory and saving space for an NSC system (including triggeting filters) is imple 8000 (low-power Z-80 equivalent) microprooremed in software, so the system is very flexible. The respirose of the I-Hz Mark cessor. Timing is provided by an oven-con-trolled crystal oscillator accurate to 1 part in Products L4-C seismometers is boosted at low frequencies using a filter with a gain of 100 10". A lithium battery pack supplies enough power in the existing pressure case for a 21higher at 20-s periods than at 1-s periods, so useful response to periods as low as 30 s is

This system was drsigned with the ability to arhieved. The power consumption is low perform high-resolution, high-frequency array studies of shallow structures using ronenough to cunsider deployments as long as 1 The Intersil 1M6100 microprocessor is also irolled sources. Particularly noteworthy is its used by the group a) Scripps Institute of Oceanography [Aloore et al., 1981]. Four ionuse of a commercial cartridge rerorder. This is a great advantage because the tape recordally, it is very similar to the muit of Prothero er is usually one of the components difficult to build and keep running. The only prublem [1979] It incorporates three-component, 1-Hz with the rartridge recorder is its size, which sensors and a hydrophone sensor. A modi-fied Uher tape recorder provides high data rapacity and is contained in a spherical presin the standard ronliguration will not by into a 15.24-cm ID pressure tuhe. Another considsure container, as shown in Figure 1.

At the July 1982 meeting D. Bibee report eration with a cartridge recorder is that mechanical vibration associated with the high tape speed will most likely shake the seismonieter. This means that a semironductor

ed on a new digital instrument using an RCA COSMAC 1802 microprocessor. It has a hydrophone for a sensor and was designed primarily to accurately record the source-time function of large explosive sources used in refraction studies. Digital data are recorded modifications to the UCSB interpentinquake on the same recorder that the Oregon State University group previously used for analog recording *Uohnson*, S. H., et al., 1977]. OBS [Prothero, 1979] to optimize it for the recording of teleseisms. A block diagram of the electronics system is shown in Figure 4. Three-romponent, gindhal-level seismometers

C. Young reported on an interesting seismic data recording system [Forig, 1982]. He designed a seismic data recording system for land deployment that could be constructed for less than \$500. He chose a CODEC chip for the A-D, which encodes the inject rlata with an 8-bit logarithmic code, A Motorola 6805 microprocessor is used to control the gain-ranging, triggering, and recording logic. Recording is clone on an inexpensive analog recorder. Tests of the data reconstruction algarithm with real data showed that the signal in the thue chanain could not be distinguished visually from the original signal.

When travel time and wavelorm synthesis are the priorary data interpretation technique

Article (cont. on p. 114)

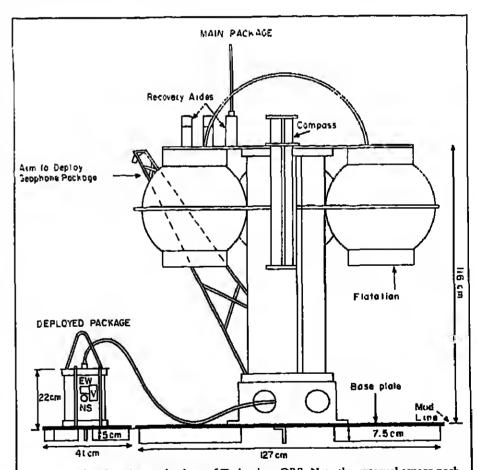


Fig. 1. The Massachsisens Institute of Technology OBS. Note the external senso age which improves isolation between the main instrument and the sensurs [Matlaboul and Solomon, 1977].

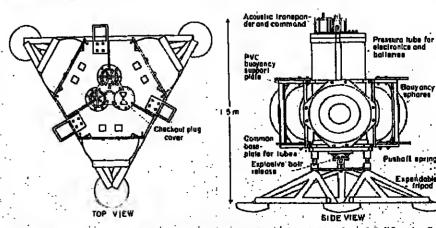


Fig. 2. Diagram of an ocean bottom seigntometer from the University of California, Sana Barbara. The machine consists of three tubes connected by a common baseplate and has the capacity to hold enough batteries for a 1-year deployment,

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this system should be quite adequate and ofler R good deal nl economy. The system was designed for experiments where a rather few recordings with a great number of stations is needed. It has applications for OBS (probably with greater recurding capacity) where very inexpensive instruments might be useful.

Tape recorders have been one of the trouhlesome components of DBS systems. Digital recorders have been used for years by the National Aeronantics and Space Administra tion for satellite data recording and playback. These are much inn expensive for OBS capsules given the funding resources available. OBS engineers have used mndified, commercially available analog recorders with good success. Prothero [1976] used an immodified Sony T'C80HB recorder to record appruximately 2.5 Mb of digital data. A similar recorder (Uher 5" reel-to-reel) has been modified by R. Moore of Scripps Institution of Oceaningraphy to record 20 Mb. Unfortonately, the Uher is mechanically nuisy and large huffer memories are needed to ohtain uncontantinated records. The Sony TC800B was quieter lint is no longer available. Acedik et al., [1978] have developed a digital tape recorder capable of recording continuously for 130 hours. This converts to approximately 70 Mb of capacity. Mettaboni and Solomon [1977] have constructed a standard formut, ninetrack recorder which stores 10 Mb, R. Muore has recently completed a prototype of a recltie reel recorder with 140 Mh data capacity. Several commercial options are available. Rockeh [1982] has successfully incorporated Quantex cattridge recorder in an OBS package. This stores 17 Mb and uses a 300-ft. (91m) cantridge tape system. A 67.3-Mh cartridge recorder is manufactured by 3-M Corparation (HCD-75). These recorders all require a good dead of power and start and stop quickly, so they would be expected to cause quite a bit of vibrational nuise. Their namer can be reduced between recording periods, so even through they are high-power devices the total energy to write a tape may be small. The Quantex requires 0.3 A h at 24 volts. The high vibration expected will require large bullers for the data so that the recut der need not be turned on during the event being sampled; new, large-capacity CMOS memory chips make this feasible.

Event Triggering and Data Compression

Since data storage is a major problem for OBS capsules, it is natural to ecaluate methods of data compression for this application. The most community used method of data compression is event-triggering. This system was first successfully used in O8S capsules by Protheso [1974] and Ambiter and Solomon [1974]. These instruments used an analog rrigger which compares a short-term average (STA) of the background noise to a long-term average (LTA). When the STA/LTA ratio immps in more than 8, the recorder turns on for 8 seconds. Recording of the event onset is assured by a digital delay line between the recorder and the analog-to-digital converter (N-D). The rerotder time is increased (cluring an event) for each new trigger so that long events are fully recorded. Newer microcarthquake trigger algorithms follow ap-proximately the same principle. Event dura tion is included in the trigger criterion, which can significantly reduce triggering due to im-pulsive shocks often caused by biological activity in shallow water. Again, the adramage of microprocessor systems is that these trip ger enmoutations can be carried out in sol ware, and may be easily changed and opti-

Teleseismic triggering algorithms for small computers have been reported by Goforth and Herrin [1981], Prothern and Schnecher [1981], Econu and Allen [1983], and Murdock and Hutt [1983]. The algorithm developed by Goforth and Herrin oses Walsh transforms | Shauks. 1969) to dynamically premitten the mise spectrum and examine the frequency content of the signals. These algorithms all use the fact that teleseisms have low-frequency energy, but very little highwhile microcarthquakes have both low and high frequency estergy. The problem is that even though they are implemented on small computers they are still somewhat complex for a full software implementation. Evans and Allen use hardware bood-pass libers to determine frequency content of the signal. Prothero and Schaecher [1981] reported on a similar triggering algorithm using easily implementa-ble dignal filters requiring only shifts (divides hy 2). The illigital litters are implemented in software and their cutoff frequencies can be easily changed.

Figure 5 shows a block diagram of this systent. It is similar in concept to that reported by Evens and Allen [1981], but does not have many of the special case conditions optimized for land recording (see also *Prothero*, 1980). The signal is first hipassed to eliminate energy from the increasing low frequency noise of the ocean environment. Then the signal is hipassed by two filters in parallel, with cutoff frequencies of approximately I and 4 Hz.
The numputs of the two hipass filters are comparted and only signals with luw-frequency components which are deficient in high-frequency components are considered. This has

en to be extremely efficient at climinating false triggers. In fact, when the OBS was tested for I month in the basement of the geology department at the University of Calia, Sauta Barbara (UCS8) no false triggers were observed, yet all teleseisms which were observed on the SCARLET array stations neor UCS8 (with sufficient P-ware amplitude) were recorded. During deep-ocean deployments the system proved to be equally robust in discriminating against noise. It is anticipated that indreasing the trigger sensi-

tivity will result in increased false triggers, The full review of the possibilities for data compression for seismic recording was pre-sented at the July 1982 meeting by A. Gersho, UCSB department of electrical engineer ing. He summarized data compression techniques used in speech processing and nented on their possible application to O8S data compression. Some work has also been done on this by Lee and l'arlagaddo (1982] and Wood [1974]. There are three factors to consider in data compression: (1) fidelity, (2) complexity of the algoridam, and (3) compressed bit rate. The most basic technique of data compres-

sion consists of adjusting the sampling to optimize for the expected signals of interest. All OBS groups do this in some form or another. A more generally useful implementation of this technique would add the capability of monituring the signal spectrum and dynamically adjusting the anti-alias lilters and deci-mation accordingly. Another of the oversampling optimizations in wide use is event triggering. Further compression can be achieved hy reducing the number of bits chosen to represent the data. OBS engineers have mostused 12-bit linear digitization in the past, aut an 8-bit logarithmic encoding scheme which shows promise has been studied by C. l'oung [1982]. The second factur, complexity is critical for OBS microprocessor implemen-tation. Some LSI chips have been deceloped for speech processing, but it remains to be seen whether or not they will be useful for seismic data logging purposes.

Two less cuminon compression schemes of immediate interest are "delta modulation and "differential ending." Delta modulation is a 1-bit method which samples the data at high speed and produces a "I" if the signal is larger than the last sample, or a "0" if the signal is less than the last sample. "Adaptive delta ntodulation" increases the step size by 1.5 if two consecutive uniputs have the same polarity, and decreases it by 0.6 otherwise; this reduces the overload and granular noise. The fidelity obtainable is determined by the basic sample one and the quantization interval-Data compression by a factor of 2 is reasonable using this method, and delta modulation

A-D devices are commercially available. Differential coding simply involves storing the difference between the current digitized signal and its last value. When the slow rate (amplitude changes) are low, a great improve ment in the number of bits needed for each sample can be made. However, extra bits. needed to indicate the number of bits stored

for each sample (for deciding) will reduce the improvement somewhat. This scheme would be straightforward to implement on a microprocessor-based system and the signal fidelity would remain unchanged. Finispress sion by a factor of 2 is estimated for this, but clerer roding could probably improve it hir-

Other schemes for data compression are subband coding and transform coding. Subband coding consists of band-pass lifering de signal, transforming the lilter outputs to low frequencies, then sampling carli transformed output at a reduced rate. Franslorm coding involves transforming the data he some method (e.g., fast Fourier transforms or Walsh transforms), climinating circlinicuts with Intramplitude, and storing the remainder. This method is discussed in detail for seismic reflection data by Il'm# [1974]. He obtains a data compression of 28:1 with a lidelity of about 85%. This would probably be unacceptable to must OHS users. Table 1 is a summary of the enumpression ratios expertable from the various techniques, as presented by Gersho at the OBS technology conference. These assume that a signal-tu-noise ratio of 30 dB is required, but the range of a 12-bit A-D is needed. The actual numbers are based on speech processing needs and would need some modification, as well as testing on actual data, for OBS applications.

It would appear that adaptive delta modulation and difference coding would be the easiest to implement in existing systems. Subband or transform coding may require more computing power than existing micriquicessor systems have to spare, so specially iledicated or more powerful processors could lic needed. Clearly, there is a large potential payoff in the use of data compression algu-rithms, and important work remains to be done on this topic.

OBS Coupling and Noise

OBS coupling hus received quite a hit of attention recently. OBS intercomparison experiments have shown that identical input nals may be recorded quite differently by different instruments. At the July 1982 conference G. Sutton summarized the results of the Lopez Island intercomparison test (Sutton et nt., 1980) and what we now know about OBS coupling. The following list is a summary of possible sources of signal distortion and noise that should be considered in OBS experiment design.

OBS Naise Sources

- A. Nuise sources with geophysical origin
- Microseisat amplification
 Ocean current-induced noise 8. Signal-induced noise I. Distortion from irregular boundaries
- at sediment-rock interface 2. Complicated reflections and conversions in the sediment layer C. Signal distortions

OBS roupling effects, including vis-cous drag, differential motion between

- water and instrument, and ingriates 2. Water solument differential mation. which allo is the response to borizon
- tal mjans A Ranhant due to nostable on king of instroment on horone with small waters
- 1. Vertical to horizontal coupling soiron fatarestroil of learnest an agricult 3. ii. Assummetries caused by small state laeral heterogeneities, causing reniol-

regularities

horzontal combing

Noise sources with geoplesical edigininchale the majosersan leakground noiseke. el and ocean encrent-unboced mise. Biologial activity and cultural mose van predominate in skallow water and areas of

graphysical exploration (Phokok et al., 1986) Bon her and Irentales, 1982]. Microscian mise o strongly surface weather related (Inflant and Neorents, Phis]. In addition, the soft bottom sediments can lead to an amplibration of the microscosta noise. In spite of this, a number of recan honom noise measurements show major levels comparable to those of coastal lique sites [I harman et al., 1979; Purthers and School her, 1981). In last, on hard-neck sites near trendgecrests, the noise at slipp period is as love as drar our quier land installations.

A serious penential source of unitelyfrom vibrations induced by honous currents Corcent-induced make less been observed by a uninter of researchers, including Sutton et al. [1980], Duennebeer et al. [1981], and Kasahara et al. [1980, 1981]. The results of Kamhara a al., [1980] suggest that horizon currents frequently exercit 200 cm/s 1 and can be a major source of noise on an GBS. B'inbush and Micak [1970] show current data taken 1.2 m alroye the scalarmon at 32°N, 120°50 W (350 kin west of San Diegor than show variations between 5 cm s and tel cia s1, with the predominant frequency being Leykes per day. This neak is the "reculted" semidianal tide. which is the cause of the dominant rariation in current speed at this site. The possibility of rectilitation must be considered when ground noise is simply correlated with the retical tidal corrents to test for outensindracel mise

The behavior of the current near the betom is not simple. A boundon lare feeled an "Ecknon layer") is a transition zone between the cornent that exists "at great distame" from the boundary and that near the boundary. The mean correst velocity vector in this transition zone generally increases with distance from the scalintogo and can create reise direction. It may be laminar or turbilent and for the case of the ocean honorita admost always tredindent. For latitudes greats than 10° the critical current speed is 0.1 cm ' while a repical current speed is 3 cm s' [Himburk and Almak, 1970]. The dynamicsel the boundary layer also depend on the stable ity of density smattle ation. Little is known about this on the ocean buttom-not even be sign of the density gradient.

Possible interaction modes are directions arting on the OHS by the cuctent, or possible

DIGITAL OCEAN BOTTOM HYDROPHONE ELECTRONIC: INFOULTS CHYCLOPL DECECTOR HIGH FHEG AMP SAMPLE CHV SENSOR --- PREAMP --BACCIMIL DELONDEN BALCEBIES Ang Sali Ding DC 300 RECORDER IT.3 MBcles A CONTROL INTERFACE HATER FOREITS OR LONGOIL 1 NA TRANS -PONCER OF TECTOR N'S DATA HIS CFOCY DVA OL LIME CÓSMAC 1802 MICRO-ROCESSOR MAG HOU MENNIT CONTROL OUAL POR TIME BASE OSCINLATOR I PARTZIGO MAPPINIS CONTROL Fig. 3. Electronics systems diagram of the Woods Hole Oceanographic Institution OBS [Korlsch Wal., 1982]. local ground noise induced by pressure flucperiments because of the water layer and the trations acting directly on the bottom by the thick layer of low-velocity sediments often untulent boundary layer. The spectrum of overlying more competent, comparatively high-velocity layers. The velocity contrast at known but certainly depends on the instruthe sediment-rock interface may be quite ment itself and the current speed. Kasohara et high, leading to severe distortion from trapped and converted waves. Basement toshow that the shedding of Karman vortices pography could also distort waveform ampli-tudes, depending on the scale of irregularities chanical oscillations of the OBS at frequencies relative to the wavelength of the seismic of 3.2 to 3.7 Hz for current speeds of 18 cm s.

Signal Distortions

The Lopez Island O8S intercomparison test [Sutton et al., 1980] was conducted to compare the response of existing OBS cap-sules. What was found was that although some similarities between instruments existed. drastic differences were also apparent. The first-order coupling effect is due to the elasticity of the bottom which the OBS rests upon Sutton et al., 1980; Zelikovitz and Prothero, 1981]. The system may be described as a damped mass-spring system. The mass is the OBS instrument mass plus an added mass caused by the inertia of the water displaced by the OBS motion. The spring constant is determined by the shear modulus of the soi beneadt the instrument footpads, and damp ing is due to the radiation of seismic energy to infinity. Thus, the system will amplify fro quencies at the resonant frequency if the daniping is low enough. Figure 6 shows a typical coupling response for various conules. Note that a worst-case amplification at the resonant frequency can be as high as 15 dB. A large bearing radius gives rise to a stiff spring and a high coupling resonance (good roupling), while a smaller bearing radius lowers the coupling frequency and increases the need for a coupling correction. A large bearing radius also seems to increase the damping, so that a large bearing radius is pre-

In addition to the effect of the coupling or the vertical motion, the horizontal signals can cause important and unexpected effects. Several of the OBS packages in the Lopez Island OBS intercomparison test had small anchors relative to the size of the instrument capsule, allowing considerable rocking to occur for horizontal ground motion. Even worse (hind sight tells usl, the sensors were mounted at the end of the pressure case, so considerable vertical motion was also induced by the cock ing. This led to a good deal of cross-coupling between hurizontal and vertical signals. This was clearly indicated by the fact that crosscuupling for each instrument was proportional to its base-to-height ratio. One solution to this is to build the instrument with a high base-to-height ratio and place the sensors along its dynamic center.

out" sensors, are able to be deployed sepacessfully used in ROSE where earthquake ment was deployed on hard bottom where the accual coupling in the vertical direction

extremely low cross-roupling distortion.

There are pitfalls, however. It can be seen from Figure 6 that a typical OBS instrument package might have a coupling distortion of a factor of 2 to 3 for frequencies at the couoling resonance. For a factor of 2 coupling distortion, the instrument package will be moving at the equivalent of twice the ground motion (at the coupling resonance), or equal to the ground motion relative to the moving bottom. Thus, on sedimented bottoms where the shear velocides are low, an instrument with this characteristic will be pumping energy into Stonely waves, which will travel to the our p-out sensor and shake it In some unpredictable fashlon. Sinre the burp-out sensors cannot be conveniently separated by much more than a meter from the main package attenuation due to geometric spreading would be minimal. So, it is necessary that the main instrument package also have good cou-pling. Indeed, tape recorder vibrations and response to extraneous internal modes of vibration might also transfer to the sensor package (but at reduced amplitudes) under some ronditions. From a purely engineering viewpoint the external sensor package poses problems with the reliability of the coupling cable and the possibility that the remote sen-sor might tarigle in the anchor or have difficulty disengaging from the bottom when the OBS is released. In spite of dis, the mediod has Important advantages, particularly in high currents, and the data quality has been very good; It would be astute, however, to remain aware of the potential problems that do

Another method of dealing with the coupling problem is by an in situ calibration technique. If the dynamic mass (O8S mass plus added mass from water motion) is constant in frequency and linear over the expect-ed seismic amplitudes, a simple relationship exists between the response of the OBS to

the noise which would be generated is un-

al [1980] have performed experiments to

from the radio beacon antenna causes me-

and 30 cm s1. The amplitude was large

enough to saturate the recording system

This effect was severe in this case because the

instrument is rather lightweight and the radio

beacon antenna, which was mounted vertical-

ly at the top of the instrument, forms a reso-

source of the current noise observed by Duen-

nebier et al. [1981] where the radio beacon an-

nant mechanical structure. This is also the

tenna is high above the main instrument

package and the base-to-height ratio is very

low. The experience of other investigators in

different parts of the ocean has not been so

unambiguous. In the Santa Barbara channel

and the deep ocean west of Santa Barbara,

where current speeds in excess of 10 cm s t

would not be expected, Prothero [1981] rec-

ords noise levels that would not be unreason

able for any coastal land station. The instru-

base-to-height ratio, and the radio beacon is

loverted beneath the deployed instrument,

which would reduce the effect of currents.

Several questions arise regarding the cur-

rent noise problem. It has been shown that

reducing the profile of the instrument by

lowering the radio beacon antenna will pro-

duce improvements when currents are high.

Other investigators have no overwhelmingly

some of this is due to the different areas of

sous (which are separate from the main in-

below in the section on signal distortions.

Signal-Induced Noise

strument package, so have a lower profile! is

rdevant to this question and will be discussed

Signal-indured noise could affect ocean ex-

periments to a greater degree than land ex-

The Weekly Newspaper of Geophysics

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Cover. Fountain Square is the historic

1984 Sping Meeting will be held, May 14—17, 1984. Housing, registration, and travel information and the list of sessions to be

focal point of Cincinatti, where AGU's

held at the meeting begins on p. 122,

ability for all content of their adve

Cations Office.

operation, as well as the differences in pack-

age configuration. The use of "burp-out" sen-

obvious problems in this regard. Certainly

ment package is 2-m high but has a large

ing parameters typical of existing OBS cap-

A currently fashionable solution to the coupling problem was introduced by the Hawaii Institute of Geophysics group [Sutton et al., 1980, 1981; Byrne et al., 1983; Duschenes et al., 1981]. The sensors, informally called "burprately and at a distance from the main instrument capsulc. This technique was very sucdata of superb quality were recorded on the MIT instrument [Trahk, 1982]. The instruwould be quite good anyway. However, the separated sensor package was well decoupled from internal modes and noise generated by the large recording package and resulted in

dynamic mass up to frequencies of seismic in terest, a quantity that appears not to have been studied. Eickemeyer and Prodiero reported on results in progress of a study of the dynamic mass of two shapes of oscillating bodies: a sphere and a plate. These shapes hove dynamic added mass factors (for the laminar flow approximation) of 0.5M, and 4p, R43, where M, is the mass of the water dis aced by the sphere, ow is the water density, and R is the radius of the sphere [Batchelor, 1967]. In order to test this for sinosoidal motion at seismic frequencies, the shapes were made part of a mass-spring system which could be driven to resonance by a shaking unit. The resonant frequencies between 10 Hz and 30 Hz were compared in and out of water in a tank. The change in resonant frequency is related to the mass change. For a 13-cm diameter sphere and a 25-cm diameter disc the dynamic n the value predicted by laminar flow to within the experimental accuracy of 10%. Further experiments are being performed on larger bodies to check the scaling. If these experi-ments show similar behavior, accurate in situ alibration corrections are practical. 0700 An accurate method of seismometer calibration has led Sauter and Dorman [1982] to an elegant method of in-situ calibration. It was discovered that the seismometer callbration signal applies enough Inertial force on the instrument to cause an observable effect from the coupling to the bottom. This will show up as an additional (small) peak in the transfer function curve. A random telegraph calibration signal is applied. The output signal is correlated with the known input to obtain the seismometer response to a high accuracy, with the coupling response superim-

ground motion and its response to an inter-

nal mechanical shaker; so it is possible to im-

plement an in situ calibration using this reci-

procity [Zelikowitz and Prothero, 1981]. An im-

portant unknown is the behavior of the

An instrument with the sensor inside must be carefully designed. Of particular importance is the elimination of spurious modes of oscillation. This means that items such as flotation spheres must be connected rigidly to the main instrument package. If they can vibrate

SEISMONETERS FILTERS 18 18 MUX AND VERSCALI LOGIC preemp goin control X2-X128 COMPUTER ELECTRONICS WATCH DOG LOGIC AUTO RESTART SERIAL INTERFACE TO EXIT CPU INTERSII IMBIOO ME MORY SYSTEM BATT ERIES POWER CISTRIB RELEASE CURRENT TESTS in esternol oxtornal Limo lood Fig. 4. Block diagram of the University of California, Santa Barbara, microprocessorrontrolled OBS electronics [Prothero, 1979].

ANALOG ELECTRONICS - 1 PER SEISMOMETER

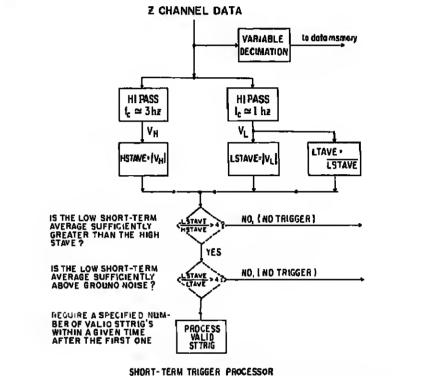


Fig. 5. Flow chart of a new teleseismic triggering algorithm. Triggering is based on the absence of high-frequency signal when low-frequency signal is present [Prothero and Schaecher, 1981(.

within the frequency band of interest, they could distort the response to ground motion. Benthos glass spheres, which are used on a number of OBS, give cause for concern. It is extremely difficult to attach them rigidly to anything since they have flexible onlyethylene protection covers through which any attachment must be made. In order to minimize cross-coupling, the base must be wide compared with the height and the sensor should located near its center line. The base should have a large sorface area, particularly when the OBS will be deployed on sediment ed areas. However, a single, large-area contact, such as a plate, will be prone to rocking if deployed on harder bottoms with smallscale relief. A tripod anchor guards against this possibility. However, on soft bottoms, a tripod anchor will respond to horizontal signals in an unacceptably asymmetric manner if die coupling is poor. The best solution might be to use a tripod anchor with large area contact pads. An in situ celibration method will give important Information on coupling when roblems exist.

Article (cont. on p. 116)

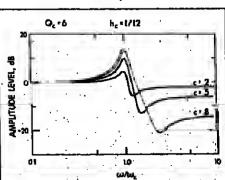


Fig. 6. Coupling distortion for various OBS coupling parameters. The OBS response must be multiplied by the appropriate curve. OBS capsules tested at the Lopez Island OBS intercomparison test behaved according to the full range of curves shown in this figure [Sutton et al.;

Effects of Ice Sheets on Climate Sensitivity, K. P.

Evidence for the Nature of the Lower Crust Be-neath the Central Colorado Plateau as Derived

From Xenoliths in the Buell Park-Green Knobs

Dintremes, T. F. O'Brien, Dept. of Geological

Sciences, Cornell Univ., August 1983.

Princeton Univ., January 1984.

Bowman, Geophysical Fluid Dynamics Program,

Operations at Sea

Operations at sea are a very important factor in the success of an OBS experiment. An Instrument which can be closed up in the land-hased laboratory and then quickly checked out prior to deployment without opening it is desirable. When an instrument nissi he opened, it should be convenient to do so. The design of a checkout system deserves a great deal of attention for more expensive and sophisticated instruments. The ability to playback data at sea is also critical both for instrument checkout and on-thespot" planning of fisrther deployments.

Summary

OBS technology has provided quite a number of engineers with some very challenging years. Many of the critical problems regarding coupling and nuise have been solved in principle. There remain important design tradeoffs regarding in situ calibration versus well coupled burp-outs, how to get low profile, spheres versus tubes, tape recorder vibrations, internal capsule modes, etc., but most of the critical questions have been at least partially answered. It remains to combine oll of the partial answers into one "ideal" OBS, an elusive il ream includged in and argued about by almost everyone involved in the field, particularly when at sea or at OBS technology meetings. However, there will be no "ideal" OBS for all applications. Some investigaturs will prefer a simple device optimized bir artificial source experiments fasting a few days to a week, while others will be looking inward long-term monitoring of natural sources. Inclividual inventiveness will assure that the "ideal" will remain ever more clusive, even as it is more diligently pursued.

Acknowledgments

The success of OBS work is due to the pa tience of the building agencies in the face of slow progress and lost instruments, the investigators who have chosen to put lorth the great effort needed to obtain seismic data from the ocean bottom, and most of all the engineers and technicians whose creativity. dedication, and determination are the critical factors in making these oftensimes buicky and temperamental instruments work under the terrible crinditions which too commonly betall a seagoing expedition. George Sutton, Sean Solonion, and Don Knelsch gave helpful suggestions concerning this mamescript.

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Comet Rendezvous Mission

A National Aeronautics and Space Adminstration (NASA) advisory team has selected a bright, short-period comet named Kupill as the target for a comet rendezvous/asteroid flyby mission to be launched in 1990. The rendezvous is the third in a series of "rone missions"--along with the Yenns Kadar Mapper and a Mars orbiter-to be proposed fulowing recommendations by the agency's Sular System Exploration Committee (SSEC) two years ago (Eos, November 9, 1989, p. 852.) It is planned as a new start in the listal year 1987 budger.

The mission will be the first tu use the new

Mariner Mark II spacecraft derived from earlier vehicles such as Voyager and Viking and intended for deep space reconnaisance. Fullowing a July 1990 space shottle lautich, the spacecraft will fly by and take close lunks at the main-belt asteroids Namaqua and Lucia on its way to a rendezsous with Kipll in

Unlike the international swarm of spacecraft that will make high-speed llyhys of Hal-ley's Comet in 1986, the Martner Mark II craft will stay with Kopff for several years, laginning about 2 years before its close encuentter with the sun when the comet is in its inaclive state. The spacecraft will orbit Koplf and study it in great detail from ranges of less than 10 km during this period. Then, after the comet begins to heat up and form tails of dust and plasma as it nears the sun, the spacecraft would back off to avoid the surrounding dust while it continued observa-

Kopff was chosen by NASA's Connet Rendezvous Science Working Group, a team of 20 U.S. and European scientists, because of its short orbital period-6.5 years-and because it is particularly active. It is also dustica than most short-period comets.

With the recent inclusion of the Mars Lieuscience/Climatology Orbiter as a new start in NASA's budget for fiscal year 1985 (Em., February 14, 1984, p. 49), two of the SSEC core sions to revitalize solar system exploration are already underway. Now that the comedasteroid mission has been proposed as a 1987 start, a Than Probe/Radar Mapper is the only one of the committee's "initial sequence" of missions as yet undefined.--7?

New Infrared Detectors

Scientists at General Electric's Research and Development Center in Schenerady, N.Y., have developed a new process for manufacturing indium antimonide detectors that will allow them to be used in infrared space satellites for the first time. The process reduces impurities in the detectors and so decreases

their "noise" level In onler to make sensitive infrared abservations, detectors using conventional itallian antimoniale must be operated at temperatures below -181°C, which require liquid nurngen or liquid helium for cooling. The new detretors will operate elfectively at temperatures as high as -151°C, however, and can be maintained indefinitely by satellite releigeration

systems powered by onbrard solar cells. Indium anthronide is the most sensitive and cheapest material available for infrared detectors, but until now its use has been restricted to imaging systems on lated or almatel aircraft because of the strict couling require-

USGS Revises **Hazards Criteria**

New criteria and terms have been adopted by the U.S. Geological Survey (USGS) for issuing formal statements to government officials and the public about geologic hazards such as earthquakes, volcanic eruptions, and

The new, two-category system comprises ? formal notice, called a hazard warning, and an informal notification for forwanting relevant but less critical information to public of-

USGS Director Dallas L. Peck described the hazard warning as 'a formal statement by the director of the USGS that addresses a geological or bydrological condition, process, ur putential event that poses a significant threat tu public health and safety and for which nearterm public response would be expected." For lesser geologić or hydrologic hazards not threatening public safety and for hazards that may require longer-range acilons, the USGS will forward information to local and state of-

ncias.

There are no specific guidelines for defining when a hazard threatens public safety or poses near-term danger, according to Clement F. Shearer, special assistant in the direct

on's office by national hazards. Esaluatione will be made on a case by case basis, at done umler the prior system.

Implemented us 1477, the previous system had there categories of hazard statement no tice of percential leazerd, hazard watch, and hazard warring "A leazard warning tending create some anxiets within a community. Peck explained. The new system will belo climinate situations in which 1 SCS state. ments might cause unwarranted public concern over potential hazards that present low risk to the public. They also will durify a new ation in which we believe a potential basard may deserve either a near-term or immediatesponse to save lives or projects."

SAR Images Updated

A new camera system using lasers and clange complet chesices and which can obein that his rather at any time or under any weather conditions has been designed by the California Institute of Techtology as part of a NASA continuing program. The system's intended to improve the imaging luncional synthetic operative radar (SAR) units. SAR units have been carried on earth-orbiting spacecraft such as the Seasat satellite and the space shuttle Codmulsia. In the past imaging was achieved as the result of a complex pioess from film. The new system transmits radar imaging data clinertly to an earth station in real time, the result being an instantanearly with sized replication.

There are real advantages in being ableto collect an emire image in real time. Tedion data roller tion, analysis, and computer posessing are climmated. The imaging audies ground and ocean surfaces will be enhanced by being able to adjust the experimentand also to reproduce observations. In addition the radar beaut penetrans muche eath, ascaling three-dimensional structure.

The new system has a sophisticated micro wave transcentier and an amenda dish designed to receive law ko affected radiation la the new design, the film that treards he is age is replaced with an acousti-optical droswhich charges up from the radar and under goes opinal transmission changes used to modulate a brult-to laser beaus. Amaber accusto-equical crystal is used tectransoicite modulated signal conorthe charge-coupled

More Quakes, Fewer Deaths

The IUS, Geological Survey's (USGS) Na tional Earthquake Information Center has sucil a laid news/good news report for 1983 The bad news is that there were more signifcant carthquakes worklyide that in any year since P.Bit. The good news is that only 2.52 persons died as the tesult of those qualer t most one-third lewer than in 1982 and les than hall the 1981 toll.

Significant cardopastes are defined at those of magnitude 15.5 or greater or those which cause casualties or considerable date age. There were 70 such treusus last yes, with 14 classified as "major" magnitude 7.9 to 7.9. "Frest quakes" of magnitude 8.0-ph have averaged about one a year in this come ry, but 1983 was the third year in a cow self

The higgest jules of 1183, both of magic tride 7.7, bit Japan on May 20 and the light Ocean near the island of Diego Garcia on November 30. Although the Japanese quite was the largest, it resulted in only 104 deals. By lar the deadliest earthquake, resuling more than half of the year's total faisher. struck northern Turkey on October 30 self h.D-magnitude shock that destroyed 50 m lages and left 25,000 persons homeles. Quakes in Lininea im December Columbia on March 31 also each claimed humbreds of lives.

Only lour of the 70 significant earlique occurred in the United States-in sol tral Itlaho in October; Coalinga, Callin May; Hawaii on November 16; and in cific Ocean off the southern coast of in February. The Idaho tremor dames lives of two children, the first earthquarters are the lives of two children, the first earthquarters are the lives of two children, the first earthquarters are the lives of two childrens. lated deaths in the U.S. since 1975, and only American fatalities in the years Damage from earthquakes in the United \$40 million.

February Streamflow

Northeast and were well above average in the poper Mississippi River badn and district mountain states thuring February the regular monthend check on the regular monthend check on the legislar months and legislar months are respectively. Blon's water resources by the U.S. Col. Survey (USGS).

USGS hydrologists said that prolonged rains in the East, abetted by warmer temperatures that melted accountlated snow and ice, pushed February streams to well above average flows at 90% of the region's 29 key index gaging stations. By contrast, in January, none these same stations reported above average

Nationwide, 55% (94 stations) of the 172 key index gaging stations reported streamflows that were well above average (within the highest 25% of long-term record), 38% reorted average flows 165 stations), and only 7% 113 stations) reported llows that were well below average.

Record or near record high streamHows occurred at 29 index stations in 13 states, including Alaska, the District of Columbia. Florida, Genreia, Inwa 131, Kansas, Michigan 12), Minnesota (5), New York (8), North Dakota, Utah (4), Virginia (2), and Wisconsin 14). Flow of the Cedar River at Cedar Rapids, lowa, for example, set a new record high flow for February of 28.8 billion liters per day (bkl) [7.6 billion gallons a day), the highest February flow in 82 years of record.

The combined average flow of the nation's three major rivers—Mississippi, St. Lawrence and Cohimbia-reflected the generally above average February streamflow conditions. Up by 11% over January, the rivers totaled 2570 bld, 4% above the long-term average for February. These three rivers drain more than half of the lower 48 states.

Hydrologist Hai Tang of the USGS National Center in Reston, Va., said that groundwater levels were generally higher than usual for February. New record-highs were recorded at key wells in lowa and Maine. The key well near Dunning, Neb., reached a level of 0.75 m below the land surface, the highest level in 50 years of record. In Nevada, the Steptoe Valley and Paradise Valley wells wer at record-high levels for February. The index well in Las Vegas, Nev., by contrast, set a new record-low level, the lowest in 40 years of ce-

Average flows of the so-called "Big Five" rivers were on substantially from January, with only the Columbia River showing a month-to-month decrease. Flows of the "Big Five" for February were as follows: the Missitsippi River at Vicksburg, Miss., Itil# hld. 2% below average, but 18% more than the flow in January: the St. Lawrence River near Massena, N.Y., 647 blrl, 13% above average. and an increase of 11% from last munth; the Ohio River at Louisville, Ky., 428 bld, equal to the long-term average, but nearly twice the flow of January; the Columbia River at The Dalles, Ore., 307 hld, 22% allove the longterm average, but clown 14% from January; and the Missonri River at Hermann, Mo., 227 bld, above the average February readings, and 84% greater than last month. (map cour-

Geophysical Events

Volcanic Events Home Reef (Tonga Is.): Submarine emption

builds islands; tephra to 12 km Submarine Volcanii (Izu 1s.): Large area of discolored water; small plumes Rabaul (New Britain): Seismicity intensifies tilt rates increase

Manam (Bismarck Sea): Pyroclastic avalanches, scoria llows; eraption columns to 5-8 km; stage-1 alert in force

Langila (New Brituin): Activity declines; 1 ulcanian explosion White Island [New Zealand): Teplira emption from new vent Galunggung (Indonesia): Small phreatic ex-

Nyamuragira (Zaire): Lava flows from NW

Pitoo de la Fournaise (Réunion Is.): Tremor declines, then eruption ends Kīlauea (Hawaii): 15ili and 16th major phases; lava fountains to 320 m; large

MI. St. Helens (Washington): Lava extrusion stops; deformation and seismidity decline to

Veniaminof (Alaska): Eruption continues; a tountains and flow El Chichón (Mexico): No new erupdons; cra-

ter lake conditions unchanged mospheric Effects: Lidar still detects aerosols but dawn/twilight colors decrease

Home Reef Volcaoo, Tooga Islands, S Pa-rific (18.99°S, 174.78°W). All times are local (= + 13 hours). An eruption in the vicinity of Home Reef was reported on March 2 at 1107. Intense submarine activity ejected a plume to an altitude estimated by an airline pilot at more than 7.5 km. A surface layer, probably puntice, extended 60 km to the NE and was 20-30 km wide, enveloping Late Island (25-30 km to the NE). Surface discoloralion of the sea covered a larger area. Another report at about the same time described a Pumice raft of the same dimensions drifting SW. South Parific Islands Airways (SPIA) reported that the activity was at 19.0°S.

Gerald Dion piloted Pan American World Airways flight 811 (Honolulu to Auckland) over the area on March 3 at about 0780. From about 18 km upwind, the eruption was visible through broken weather dou about 1 minute. A medium-dark reddish-

Earthquakes Date (UT) Magnitude Lainule Longitude of Focus Region 1422 February 1 5.7M, 34 68°N 70.54°E NE Afghanistan 2133 7.5M. 9.91°S lti0.49°E Sulomon 1s. 70.91°E 213 km February 17 1719 5.8m_b 36.43°N NE Al'ghanisian

brown eruption column rose from a submarine vent within a horseshoe-shaped island open to the E. The eruption column reached thily more than 12 km altitude iseveral hundred meters above the aircraft) where winds carried its top at least 15 km NE.

During the morning of March 4, an SPIA pilot reported that an eruption cloud was still visible, rising high above the sea surface. He saw floating pumice drifting away from the eruption site but no island appeared to have formed. However, before the emption had ended, by March 5 at 1030, two small islands had formed with a maximum elevation of about 20 m, enclosing a crater about 1500 by

Island-forming eruptions of Home Reef Have previously occurred in 1852 and perhaps in 1857.

Information Comacts: Ram Krishna, Director of Mcteorology, Fiji Meteorological Service, Private Bag, Nandi Airport, Fiji; John Latter, Geophysics Division, Department of Scientific and Industrial Research, P.O. Box 8005, Wellington, New Zealand; Gerald Dion, Box 417, Kenwood, CA 95452 USA; Meteorological Office, Nukualofa, Tonga; William S. Smith and Toni Kossarias, Federal Aviation Administration, 800 Independence Ave. SW, Washington, DL: 205!11 USA.

Submarine Volcano, Izu Ishinds, Japan (preliminary location 26.07°N, 141.13°E). All times are local (= UT + 10 hours). On March 7 at 1230, the crew of a Japan Maritime Safety Agency (JMSA) transport plane flying about 130 km N of Iwo Jima observed a fan-shaped zone of discolored sea water that extended about 25 km WSW from a submarine vent The maximum wirth of the discolored zone was about 9 km. A helicopter from the base at Iwo Jima flew over the area shortly thereafter and its crew estimated that the extent of the rerldish-brown water was roughly as large as Iwo Jima Island (about 5 by 8 km).

The next marning, JMSA personnel observed continuous submarine crimtive activity. Cray or yellowish-brown water was ejected every 10 minutes and waves spread untward from the years. The sea colors included gray, white, yellowish brown, and reddish brown. The IMSA observers saw neither plumes nor floating ejecta, although small white and rocks or reels were seen during a highby the Japan Maritime Sclf-Defense Force ([MSDF) at about noon the same day. On March 12, personnel aboard a JMSDF patrol plane again saw lloating material, and a plume about 100 m above sea level. Only discoloration was found during a JMSA flight March 13. As of the 13th, no new island had been observed at the eruption site.

The activity was located near the site of an eraption reported in 1543 at 26.00°N, 140.77°E.

Information Contact: Office of Volcanic Observation, Japan Meteorological Agency, I-3-4 Ote-machi, Chiyada-ku, Tokyo 100, Ja-

Manam Volcano, off the N coast of Pnpua New Guinen (4.10°S, 145.06°E). The following it a report from P. Loweustein.

"A please of major eroptive activity commenced at Manam's S crater in mid-February when a series of pyroclastic avalanches was discharged into the SE valley.

"Moderate strombo-vulcanian explosive ac tivity took place at the S cracer during the first half of the month, but an intensification was noted from February 12, and on the 17th the first pyroclastic avalanche was discharged. This and the succeeding avalanche on the 21st descended about 4 km from the summi Smaller avalanches were produced on most days after the 21st, usually terminating about 2 km from the summit.

"Ground and aerial inspections near the end of the month revealed that the numerous ches had obliterated most of the preexisting surface in the upper half of the valley. Trees were flattened and had lost limbs and foliage. Scorcling of vegatation hod taken place on the 200-nt-liigh valley walls and beyond to distances of 100 nt. In addition to these hot pyroclastic avalanches, numerous flows of loose scoria from rapidly accumulated airfall deposits around the vent were also noted. These scoria flows descended into both the SE and SW valleys, terminating within 2 km from the summit

"Vertical explosion activity at the S crater produced an impressive eruption column which rose to heights of 5-8 km above the vent on several days. Incandescent pyroclasts were ejected to heights of about 700 m, February 17-29. Ashfalls in coastal areas were generally light, although the accumulated thickness may have been up to several centimeters in places, resulting in the loss of branches from some trees. "The main crater was moderately active

throughout the month. Generally, the rate of ash and vapour emission was weak to moderate. Weak, fluctuating glow at night indirated small ejections of incaudescent lava within the

"Seismicity showed a strong increase at mid-month corresponding with the intensi-fied visible explosive activity. Between February 14 and 19 the amplitude of B-type events was about 8 times normal. During the remainder of the month a slight reduction to about 5 times normal levels was noted. Daily totals of volcanic earthquakes were steady a about 1700 (February 1-12), rose to 2100 (February 13-25), then returned to 1700.

'The stage-1 volcano alert, declared on January 24 in anticipation of increased activity, was maintained in force throughout the month. Warnings were issued to the local population to stay out of the SE and SW val-

Information Contact: P. Lowenstein, Prin cipal Government Volcanologist, Rabaul Vol-cano Observatory, P. O. Box 386, Rabaul, Papua New Guinea.

Earthquakes

Information Contact: National Earthquake nformation Service, U.S. Geological Survey, Stop 967, Henver Federal Center, Box 25046, enver, CO 80225 USA.

Meteoritic Events

Fireballs: SW and Manitoba, Canada; Arizona, Connecticut, Florida, Kausas, Maryland, and Oregon, USA

This is a summary of SEAN Bulletin, 9(2), February 29, 1984, a publication of the Smithwonian Instimion's Scientific Event Alert Network, The contplete Home Reel, Submarine Volcano, and Manan reputs are included; the earthquake report is an excerpt. The complete bulletin is available in the purrofiche edition of Eas as a mirrodulse simple ment of as a paper reprint. For the interoliche, or-der document F81-003 at \$2.50 (U.S.) from ACC Fulfillment, 2000 Florida Avenue, N.W., Washingon, DC 2000). For the paper reprint, order SEAN Rulletia tercing column and issue mumbers and issue date) through AGU Separates at the above address. the price is \$3.50 for one copy of each issue number for those who do not have a deposit account, \$2 for those who do, additional copies of each issue from her are \$1. Subscriptions to SEAN Bulletin are available from AGU Fulfillment at the above address; the price is \$18 for 12 monthly issues mailed to a U.S. address, \$28 if mailed elsewhere, and must be

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Books



The Montgolfier Brothers and the Invention of Aviation

Reviewed by Charles H. Moore

Charles C. Gillispie, Princeton University Press, Princeton, N. J., xi + 210 pp., ISBN 0-691-08321-5, 1983, \$35.

The liest hat air balloon ascension over Paris in September 1783 has been described so prarry times that it and its passengers-the slreep, the conster, and the duck-have juinert Benjamin Franklin and his kite in the folklore of our culture. Not so well known is the earlier hirrory of hallooning; that the bruilrets Montgollier had demunstrated their had air balloons repeatedly for several manths prior for the ascent over Paris; or that the physicist Charles, urged onward and financed hy an enthusiast. Barthélency Faujas de Saint-Fond, launched successfully the first labele hallorn filled with hydrogen over Paris more than 3 weeks prior to the memorable ascent

of the sheep, and rooser, and the duck. For all of its well-documented detail, the book is readable and enjoyable. It is a wellwritten but complex book in which Professor Gillisple develops a trumber of subjects to re-

create the era in perspective. The origins and the disposition of the Montgolfiers, the industry of the period, the idea of capturing heated air are all reported in tletail. The attempts to obtain government funding and the promotional activities in Paris were forerunners of the modern techniques for obtaining sup-

port of research activities. The account of the overly ambitiour dentonstrations required of the infant art of ballooning is timeless. A similar and predictable sequence developed 160 years nr so later, af-ter the end of World War II, when Jean Piccard adapted plastic films to the construction of high altitude balloons. A 20th century entrepreneur with an ondook similar to dust of some in the 18th century seized on Piccard's idea and sold the American Navy on an ambitious program in which a chister of 100 large balloons would be used to carry a gon-dola with about 100 instruments to an altitude of about 100,000 feet (30 km).

The ascent was scheduled with a fixed date in 1947 before the first useable, plastic balloon was even constructed. The eventual inflating test of the first new balloon was a disasier, worse than any suffered by the Montgolfiers. Under a light wind, the gosramer balloon became a vast, unmanageable spinnaker sait breaking all of the restraining lines and all hopes for the experiment that had been plunned. Eventually, techniques to handle the new technology were developed and a more perceptive miniagement rescued the program by the creation of Project Skyhook in the Office of Noval Research. This ap-

proach led to a remaissance of scientific bal-looning that continues to this day. The high cost of helium, the inflation gas for these modern charlières, has led to a resurgence of Interest in hot air bolloons. Over the past 20 years Montgolfier balloons have been improved by Ed Yost and his associates through the use of high-intensity, propane burners and newly designed envelopes of improved fabric so that hot air ballooning has

become a major sport worldwide. While Professor Gillispie's account of early ballouring ir foscinating and a paradigm of later luman endeevors, even more interesting is the latter part of the book with its histury of early attempts to construct internal combustion engines, of Joseph Monigoffier's invention of the hydraulic ram, of the early kinetic energy concepts, of Carnor's antecedents, of bridge design, and many other senti-nal nudertakings. As a rundent of thunder-norms, I em delighted to learn of Joseph Montgolfier's electrical explanation for the formation of intense rains that even then were observed to fall after nearby lightning

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by his ascension (the first manned one, in

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This appraisal, I think, is still appropriate.

Certainly the undirectability and the limita-

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RESEARCH SCIENTIST \$A24,344-\$A35,806 **DIVISION OF SOILS**

ADELAIDE SA CSIRO conducts scientilic end technological research in leborstories located throughout Austrelia and employs about 7,500 staff, of whom some 2,900 ere professionel adaptiets. The Organization's research activities are grouped into five inelliutas: Animel and Food Sciences, Biological-Resources, Energy and Earth Resources, Industrial Technology and Physical Sciences. The CSIRO Division of Soils is a membar of the Institute of Biological Resources.

FIELD: Soll physice/hydrology/applied methametics

GENERAL: The CSIRO Division of Bolls conducts research into most especie of soil science, including the physics, chemiatry end biology of soils, end the integretive disciplines of pedology end geomorphology. It eleo eesks the epplication of its research in agriculture and in other areas of science and technology. The Division has laboratorias in Adelaide, Briebene, Cenberrs and Townsville.

DUTIES: The eppointes will underteke research as pert of e progrem etudying the sifect of climete and land manegement on the entry and redistribution of weter in soils. If it is enticipated that the principles developed will be used in etudies of surface water management end plant/water relations. The eppointee's research will be on the applied physics or mathematical aspects of this progrem. Initially the work with be directed to the study and interpretation of the distribution of deutsirum and oxygen-18 in relelion to the movement of water in soils and will involve both laborstory and field studies.

The appointee will be based at the Division'e Adalatde Leboretory which is equipped with a VG602 mass spectromater, a wide range of equipment for studying the physical end chemical properties of soil and water, and drilling rige designed for soil sampling. Computing tecllities are available on site, and the laboratory is linked to the CSIRO Cyber-76 computer.

QUALIFICATIONS: Applicante should have a PhD degree or squivalent qualifica-tions, supported by setablished research ability in one or mora of the following flaids: soil physics or pure physics, physical chamistry, applied methametics, or hy-

TENURE: The eppointment is for an indefinite period, following setial actory completion of a probationery period. Australien Government superannuation benefits are

APPLICATIONS: Steting Iuli personal and professionel detalla, the nemes of et lees) two scientific ralarsas and quoting ralarenca No A0539, should be directed to:

C9IRO Division of Solis Privata Bag No. 2 GLEN DSMOND SA 5054 AUSTRALIA

By April 19, 1984

CSIRO RESEARCH SCIENTIST/ **SENIOR RESEARCH SCIENTIST**

\$A24,344—\$A35,806 DIVISION OF SOILS **CANBERRA ACT**

CSIRO conducts scientilic and technological research in isborstoriea located throughout Austrelia end employs ebout 7,500 stell, of whom some 2,900 are prolessionel acientists. The Organizetion's research activities ere grouped into five inallities: Animal and Food Sciencea, Biological Resourcee, Energy end Earth Resources, Industrial Technology end Physical Sciences. The CSIRO Division of Soils is a member of the Inatitute of Biological Resources.

FIELD: Soil Physics and Physical Chamiatry

GENERAL: The CSIRO Division of Soils studies the physics, chamistry end biology of soil and other porous madis, together with the integrative disciplines of pedology and geomorphology. It also sasks the application of its research in agriculture, and other areas of science and technology. The Division has leboratories in Adeleide,

The Division is airengthening a resseroh program dealing with the physical and mechanical properties of oleys, clay soils, end colloidat suspensions. These properties derive from interections between the mineralogy, the structure and the physical chamistry of the system. The situation is complicated by weter and soluble ealt

DUTIES: The appointee will provide theoretical support for this program end in per-liculer would be expected to undertake research in some of the following areas: thermodynemics of cley soils; stress fields in clay soil during water content change end loading end their relationable to shear end consolidation; physical chemistry end machenics of aqueous solution flow in clay soil in relation to soil atructure; ma-chenical properties, including the rhaology and etructurel stebility, of saturated end unsetureted cley soile, end cley euapansions.

QUALIFICATIONS: A PhD degree or equivelent qualifications, with demonstrated research ability and training, for example, in soil physics, soil mechanics, physical chemistry, and/or applied methanetics.

LOCATION: The eppointee will be besed in Canberre, ACT.

TENURE: The appointment is for en indefinite period, lollowing satisfactory completion of a probationery period. Australian Government superannuation benefits are

APPLICATIONE: Stetling full personal and professional details, the names of st least two referees and quoting reference No A0525, should be directed to:

CSIRO Division of Solis GPO Box 639 CANBERRA ACT 2601

By April 19, 1984.

CSIRO RESEARCH FELLOWSHIP

\$A24,344-\$A35,806 DIVISION OF SOILS **CANBERRA ACT**

CSIRO conducts scientific end technological research in laboratorise located throughout Australia and employe about 7,500 etail, of whom some 2,900 are professional scientists. The Organization's research activities are grouped into live institutes: Animal and Food Sciences, Biological Resources, Energy and Earth Resources, Industrial Technology and Physical Sciences. The CSIRO Division of Soile is a member of the institute of Biological Resources.

GENERAL: The CSIRO Division of Solls atudies the physics, chemistry and biology of soils and other porcus medis, together with the integrative disciplines of pedology end geomorphology. It also seeks to establish principles for the application of soil science to agriculture, forestry, hydrology, engineering end conservation. The Division has isboretories in Adsiatds, Brisbane, Canberra and Townsvills.

The Division proposas to appoint a Research Fallow to participate in "Siregcrop", e collaborative project on soil and other constraints on irrigelate crop production within the CSIRO institute of Biological Rasources. The Division of Soile component of the project will focus on structurel and mechanical problems presented by soils in which structurely unstable surface horizone overfile dense and impervioue clay aubsoils. Field work will be concentrated at a still close to the CSIRO Centre for Irrigation

DUTIES: The eppointae will study aspects of the neture, origin and consequences of soil structurel instability in irrigation agriculture. The etudy will address the physical-chemistry of these soils in relation to their mechanical and physical properties, and will seek to identify means for their emailoration to ensure long-term orop productivity. The research will involve both laboratory and field studies and will complement that of biologists and applied scientists in Adeleide, Canberre and Griffith.

QUALIFICATIONS: A PhD degree or equivelent quelifications, with demonstrated research ability end training in soil physics, soil mechanics or physical chemietry.

LOCATION: The auccessful epplicant will be based in Canberre, ACT.

TENURE: A fixed term of 5 years. Austrelian Government Superennuation benefite

APPLICATIONS: Stating luli personal end professional detells, the namee of et least two referees and quoting reference No A0584, should be directed to:

CSIRO Division of Solis CANBERRA ACT 2601 AUSTRALIA

By April 19, 1984.

The Sixih Annual Ground Water Heat Pump Conference Fawcett Center for Tomorrow Columbus, Ohlo

Design, Installation and Sampling of Ground Water Monitoring Wetts: A Short Course Orlando Marriott Hotel Orlando, Florida

April 26-28 Woter Well Design and Construction: A Short

Course for Engineers Denver Airport Hilton Inn Denver, Colorado

Ground Water Modeling Without Mathematics Denver Airport Hilton Inn Denver, Colorado

The Complete Ground Water and Well Technology Short Course Hitton Inn North Columbus, Ohla

May 14-18 Ground Woler Investigations at Hazardaus Materiols Sites: An Intensive Safety Short Course (Two Modules) Fawcett Center for Tomorrow Columbus, Ohlo

May 23-25 The Fourth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitorina Fawcett Center for Tomorrow Columbus, Ohlo

June 6-8 Water Well Design and Construction: A Short Course for Engineers **Sheraton Hortford Hotel** Hartford, Connecticut

June 12-13 Northeast Graund Water Exposition Hattford Civic Center Hartford, Connecticul

June 22-26 Practicat Applications of Ground Water Geochemistry Banff Springs Hotel Banif, Alberta, Canada

The Complete Ground Water and Well Technology Short Course Hilton Inn North Columbus, Ohlo

July 25-27

Boston, Massachusetts

Ground Water and Unsaturated Zone Monitoring ond Sampiling: A Short Caurse **Boston Marriott Newton** Boston, Massachusetts

July 30-August 3

Ground Woller Investigations of Hazardous Materiols Sites: An Intensive Salety Short Course (Two Modules) Denver Airport Hillon Inn Denver, Colorodo

South Atlantic Well Drillers Jubliee Myrtle Beach Convention Center Myrtle Beoch, South Carolino

August 7-10

Ground Woler Modeling Without Molhemotics Logon Airport Hillon Inn Boston, Mossachusetts

August 15-17

Conference on Proctiol Applications of Ground Water Madels Fawcett Center for Tomorrow Columbus, Ohlo

August 21-22 Ground Water Investigations at Hazardous Moterials Sites: An Intensive Safety Short Course (Module Lonly) Thunderbird Hatel Bloomington, Minnesoto

August 27-29

The Impact of Mining on Ground Water Denver Airport Hilton inn Denvet, Colorado

September 5-7

Ground Water and Unsaturated Zone Monitoring ond Sampling: A Short Course Hilton Inn North Columbus, Ohlo

September 10-12

The Complete Ground Water and Well Technology Short Course Hilton inn North Columbus, Ohio

September 24-26 International Water Well Exposition Las Vegos Convention Center Las Vegas, Nevado

October 15-18 Ground Waler Modeling Without Mothemolics Sheroton Horbor Island East San Diego, Colifornia

October 23-25 NWWA Western Regional Conference on Ground

Woler Monogement Sheraton Horbor Island East San Diego, Collornia

October 29-31 NWWA Eoslern Regional Conterance on Ground Water Management Sheroton World Holel Orlando, Florido

November 5-7 Petroleum Hydrocarbons and Organic Chemicals In Ground Wolor: Prevention, Delection and Restoration Guest Quoriors Wosl and intercontinonial Holel

Houston, Texas

November 5-7 The Complete Ground Water and Wall Technology Short Course Hilton Inn North

Columbus, Ohlo

November 12-17 International Conformica and Exposition on Ground Woler Technology Johonnesburg Showgrounds Johonnesburg, South Africa

November 27-29

Water Well Design and Construction: A Short Course for Engineers Fawcett Center for Tomorrow Columbus, Ohlo

November 27-30

Ground Woter Modeling Without Mothematics Fort Worth Hilton Inn Fort Worth, Texas

December 3-5

Ground Water and Unsaturated Zone Monitoring and Sampiling: A Short Course Sheraton Airport Inn Phoenix, Arizono

December 10-12 Ground Water and Unsaturated Zone Monitoring and Sampling: A Short Course Tampa Marriott Westshore Tompo, Florida

National Water Well Association/500 W. Wilson Bridge Rd./Worthington, OH 43085/614-846-9355 I

NSF's Division of Atmospheric Sciences is seeking high-quality professional applicants as AssIsfant/Associate Program Director and Program Director for positions which perindically hecome available. These positions are excepted from the competitive civil service and are filled on a one- or two-year robutional basis under the provisions of NSF's Rufatar Program. Typical duries will involve propusal review, advising applicants, budget development, site visits, program development and others

advising applicants, budget development, site visits, program development and of er administrative daties.

Vacancies to be filled in the Divisian are in file following greas of interest:

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Applicants should have a Ph.D. or equivalent experience in the appropriate discipline and, for the Assistant Program Director, 3 to 4 years of successful scientific research experience beyond the Ph.D.; Associate Program Director, 4 to 6 years of successful scientific research experience beyond the Ph.D.; and, for the Program Director 6 to 8 years of successful scientific research experience beyond the Ph.D.; is desirable. The per annum salary images as follows: Assistant Program Director—\$30,000—\$45,000; Associate Program Director—\$30,000—\$45,000; Associate Program Director—\$45,000—\$65,000. Applicants should refer to Announcement EOS/ATM when submitting resames rincluding current salaryl to the National Science Foundation, Personnel Administration Branch, Rm 212, 1800 G Street, NW., Washington, D.C. 20550. Attn: Catherine Handle. For further information call: 202/357-7840. Henring impaired individuals should call: TDD 202/357-7492.

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The Isotope Geochemistry group of the Los Alamos National Laboratory is secking candidates for a postdoctoral appointment in analytical, separation or radio-

This opportunity will include participsrion in a solar neutrino experiment |Science 216, 51 (1982)| with involvement in separation and punfication of trace quantities of technetium from large quantities of molybdenite. Experience in vet chemical separation is required.

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more than three years past their Ph.D. are invited to apply. U.S. Cirizenship is re-Send your resume in confidence to:

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The Department of Geology/Geography invites applications for a termite track position in geoclemistry at rank of Graduate Associate Professor beginning August 1984. Position involves development of graduate research program at Master's level. Specialization in environmental geochemistry/geochronology/isotope geology desired. Send letter of application, resume and names of three references to: Dr. Oavid Schwartzman, Department of Geology/Geography, Howard University, Wathington, DC 20059.

Sentor Apptheniona Chemist. Keves Eurpotation is seeking an intlividual with a strong Analytical Chemismy background, in particular in X-ray Fluorescence, for Applications Laboratory.

Three years of experience in Tab or Industrial Analytical Problem solving using XRF is required. Advanced degree in Physical Science or Engineering is preferred. Position requires Applications support to Marketing, Sales and R&D open toons. Submit resume to: Mr. Brew Isaas, Keves Corporation, 1101 Chess Drive, Foster City, CA 94404.

EOE MF/H/V.

Air Force Geophysics Laboratory Geophysics Scholar Program (1984–1985). The Air Force Geophysics Laboratory (AFGL) and The Southeastern Center for Electrical Engineering Education (SCLEE) amounts that applications are invited for research appointments do ning the 1984–1985 year in the Geophysics Scholar Program. This program provides research opponunities of 10 to 12 months duration for selected Engineers and Scientists in per form research in residence at the AFGL, Harscom AFR, near Boston, Massachuseus. Scholars follow selected primarily from such helits as Garphysics, Almospheric Physics, Meteorology, Inn Chemistry, Applied Science, Mathematical Modeling using Lampaters, and Luginering.

To be eligible, randidates must have a Ph.D. or equivalent experience in an appropriate technical

To be eligible, caribblates into thate a Ph.D. or equivalent experience in an appropriate technical held. Some appointments may be confirmed prior to August 1984 so early applications are encouraged. All qualified applications will receive ormaleration without regard to rate, color, religion, sex, or national origin. Application Headline for September Appointments: Angust 1, 1984, For burdlet information and application forms contact SCEEE, 1101 Massachusetts Avenue, St. Cloud, Fl. 32769 Telephone; 13051-802-6146.

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STUDENT OPPORTUNITIES

Research Fetlowships at the University of Notre Oane. Fellowships in groundwater physics, groundwater chemistry, anactobic processes and bioengineering are currently available in the Environmental Engineering Program of the Givil Engineering Department. Successful applicants will be awaitled annual stipently of up to \$1000/mo. plus full tubion. For additional information, contact Dr. Aaron A. Jennings, Department of Givil Engineering, University of Natre Dame, Notre Dame, IN 40536 (219-259-3846).

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Medallion on the plaque awarded to Tectonics by the Association of American Publishers for excellence in journal design

Tectonics Wins **AAP Award**

AGU's newest journal, Tectonics, won the 1983 award for excellence in journal design and production given by the Association of American Publishers, Inc. (AAP), in the eighth annual professional and scholarly publishing awards competition, Edited by John F. Dewey, the himonthly journal is a joint publication of AGU and the European Geophysical Society, Paul E. Tappunguer is the Euro-pean editor and B. C. Burchfiel is the North American cititor. The journal is now in its third year of publication.

AAP was especially impressed that AGU met its stated objectives in the production and presentation of the journal. Those objectives included increasing the number of words per page, allowing the publication of more science without significantly lucreasing the size of the journal, and providing higher quality paper to enhance overall quality and remoduring of lightes.

To our knowledge, this is the first time the award has been given to an author-produced journal," said Judy G. Holoviak, AGC director of publications, public information, and marketing, "I'm really pleased that a pro-tessionally judged contest can give proper recognition to author-produced copy.

Under the auspices of the professional and scholarly publishing division of AAP, an inde-pendent panel of judges from the publishing ndustry aml from the industrial, medical. and scientific community was canvened to judge the more than 320 professional and scholarly two ks that were nominated. The works range across the spectrum of science. rechnology, business, and humanitites nominared for the awards competition. The more than 300 publisher members of the professional and scholarly publishing division of AAP account for the majority of book output and sales of professional and scholarly works in the United States.

Honorable mentions for excellence in journal design and production were awarded to Winterthur Portfulio, published by the University of Chicago Press and edited by Ian M. G. Quimby, and to the Journal of Biomedical Mu-terials Research, published by John Wiley & Sous and edited by A. Norman Cranin.

The award plaque, displayed at AGU head-quarters, states, "1983 Excellence in Journal Design and Production Presented to American Geophysical Union for Tectonics, Editor-in-Chief: John F. Dewey, Professional and Scholarly Publishing Division, Association of American Publishers."—BTR

AGU Membership Applications

Applications for membership have been received from the following individuals. The letter after the name denotes the proposed primary section affiliation.

Leonard A. Barrie (A), Kenneth Paul Bowman (A), Donald K. Brambeld (A), Mark Clark, Craig M. DePolu, Robert G. Cilison (G), Boilliu G. Gilbert (T), Mark N. Goliz (H), Dennis J. Gregor, Gary B. Griggs (O), Jatar Hadizadeh (S), Rua K. Hayden, Allan D. leclu (A), William Brem Hempkins, Charles David Hendry (A), George Henry (11).

David Brian Jenkins (A), Kimberly S. Julitz (SS), Terno Kanazawa, Benny Kullinger (S), Jonathan W. Lott (O), R. J. Luxmore (H), Gerald L. Martser (G), Clark Markell (H), Maria Martinez, William D. McGov (10, C. Thomas McElroy (A), Francisco Medina (V). Masanichi Miramoto (P), Ronald M. Morosky (H), John W. Morse (O).

Bremla L. Norcross (O), jongen N. Pihi (S). Filippa Radicati, Michael Retelle (Va. Frans J. M. Rictmeijer (A), Ian Rawbuttom (Ht. John Scott (11), Reith Sommer (O), William N. Stammers (14), Marjorie L. Summers (V). Kathy Y. Tonnessen (11), Paul Travis, Parker, J. Wigington (11), James C. Win her (V), Phil-p G. Woods.

Student Status

Helen J. Anderson (1), Law Arenberg (V), Shih-Bin Chang (GP), Mo hael Christie (H), Makolin E. Cox (V), Isabelle Cozzarelli (II), L. Ford Differty (O), Robert J. Ellison (T), jeffrey G. Feehan (T), Benjamin S. Giese, Paul Keem Gultard el c Mahbub Hasan (H),

Catic Helm, Andrew J. C. Hugg (Vi.) Dale R. Issler (1), Graig Jarchow (8), Beth Laband (O), J. H. Leere (11), Sieven A. Lonmis (H), Douglas M. Mach (A), Keyin A. Maher (T), Papa D. Maniar (V), Ritsuko S. Matsutra (S), Gabriele Moebring-Erdmann (T), Jonathan M. Nelson (A), Scott Nutter, Marino Osios (T), Lee Peyton (H).

Mark Rickensen (H), Michael E. Rotherts (V), Eurdip S. Sahota (T), Suresh Sautanam A), Joachim Schumacher (A), Brait S. Singer (V), Ole Martin Speilstad (O), Joel W. Sparks I. Scott Startatt (O), Lori Venner (H), Robn J. Weeks (T), Rudolf Widmer (S), Kenneth R. Wilks (T), Jack Winman (H), David A. Worthington (S), Steven A. Young (T).

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China and Global Climate

October 30-November 3, 1984 Sympo-

Meetinas

AGU Spring Meeting

Travel, Housing, and Registration, and Session Summary

The 1984 Spring Meeting of the American Geophysical Union will be held in Gincinnati, Ohio, May 14-17, at the Convention-Exposition Center. The center, located in the heart of the city, is an ideal meeting site; a skywalk system links the Convention-Exposition Center with anajor down town liotels, restaurants, and shops. Cincinnati is easily reached by three major highways and the Greater Cincinnati International Airport (only 15 minutes from ilountum].

Reglatration

Everyone who attends the meeting must register. Preregistration received by April 20 saves you time and mimey. The fee will be refunded to you if AGU receives written notice of cancellation by May 7. Registration rates

	treregis- tration	After April 20
lembo	\$70	\$85
indent Member*	\$30	\$45
terned Senior Member**	5.301	\$45
Somember	\$95	\$110
tudent Nonnember	\$-(0)	\$55

Strolent fee los been rolled back to **Age G5 or over and retired from full-time

Registration for 1 day is available at one half the allove rates, either in alrance or at the merting. Mendiers of the American Congress on Surveying and Mapping, the Anterican Meteorological Society, the American Society of Photogrammetry, the Canadian Geophysical Union, the European Geophysical Union, and the Union Geoffsica Mexicana may register at the AGU mentber tates.

If you are not a member of AGU and you register at the full meeting tate, the difference between pumber for student member) registration and nonmember registration will be applied in AGU three if a completed membership application is received at AGU by July 9, 1984.

To preregister, fill out the registration form and return it with your payment to AGU by April 20. Preregistrants should pick up their registration material at the registration desk located in the Convention-Exposi-tion Center. Your receipt will be included with your preregistration material. Registra-tion hours are 8 A.M. to 4 P.M., Monday through Thursday. On Sunday, May 13, you may register from 5:30 P.M. to 7:30 P.M.

Hotel Accommodations

Blocks of rooms are being held at the Clarion Hotel (formerly Stoulfer's) and at the Netherland Plaza for those attending the Spring Meeting. The Clarion (\$55 single, \$65 double) is immediately adjacent to the Convention Exposition Center. The Netherland Plaza (\$56 single, \$66 double) is approximately three blocks from the Center, easily accessible by the skywalk system.

Hotel reservations must be received by April 16, 1984, to be confirmed. Mail the completed housing form directly to the hotel of your choice. Do not write or telephone AGU for housing reservations.

Selentific Sessiona

The program summary appears later in this issue. The preliminary program with the abstracts will be published in the April 17 is-sue of Eas. The head meeting program with presentation times, will be distributed at the meeting. Scientific sessions will be held at the Convention -- Expusition Center.

Exhibits

Q

Exhibits of instrumenation manufacturers book publishers, government agencies, and other organizations will tun Iron Tuesday. May 15, to Thursday, May 17, 9 A.M. to 5 P.M. daily.

Special Events

An kebreaker party on will be held on Monday evening in the Grand Ballmom of the Clarion Hotel, from 5:30 to 7. This will be the opening social event of the meeting.

Awards Ceremony and Reception

All meeting participants are invited to at-tend this event! The Awards Caremony will be held in the Hall of Mirrors at the Netherland Plaza fintel at 6:00 P.M. on Wednesday. May 16. A reception in the Third Floor Foy-er will immediately follow the ceremony and

offer a time for you to meet, congratulate, and share a glass of wine with those being

President's Dinner

The President's Dinner, held in honor of the medalists, awardees, and Fellows will begin at 8:00 P.M. in the Continental Room of the Netherland Plaza Hotel, Black tie is optional. Dinner tickets are \$25 per person. Purchase tickets with your preregistration be-cause only a limited number will be available

for sale at the meeting.

Complimentary refreshments will be served Monday through Thursday at the Convention Center, 9:30 A.M. to 10:30 A.M. and 2:30 P.M. to 3:30 P.M.

Program Summary

Approaches to IGBP, Mon PM Space Research, Tues AM

ospheric Sciences Acid Precipitation, Wed AM Earth Rotation I. Thurs AM Upper Atmosphere, Thurs AM General Meleorology, Thurs PM

Gravity Analysis I, Mon AM Gravity Analysis I, Mon PM Precise Positioning: SLR/VLB1, Tues AM Trends in Geodesy, Tues PM Geodetic Methods, Wed AM California Tectonophysics, Wed PM Georlesy and Tectonophysics, Wed PM Earth Rotation I. Thurs AM Earth Rotation II. Thurs PM

Geodynamics Pgm./CDP, Mon AM Cuntinental fectorics I, Mon PM Grarity Analysis 1, Mon PM Precise Positioning: SLR/VLB1, Tues AM Crustal Studies, Tues PM California Tectonics, Weil PM Geolesy and Tectonuphysics, Wed PM MAGSAT, Wed PM Earth Rotation I, Thurs AM Earth Rotation 11, Thurs PM Gravity Analysis II, Thurs AM

AMERICAN GEOPHYSICAL UNION SPRING MEETING MAY 14-18, 1984

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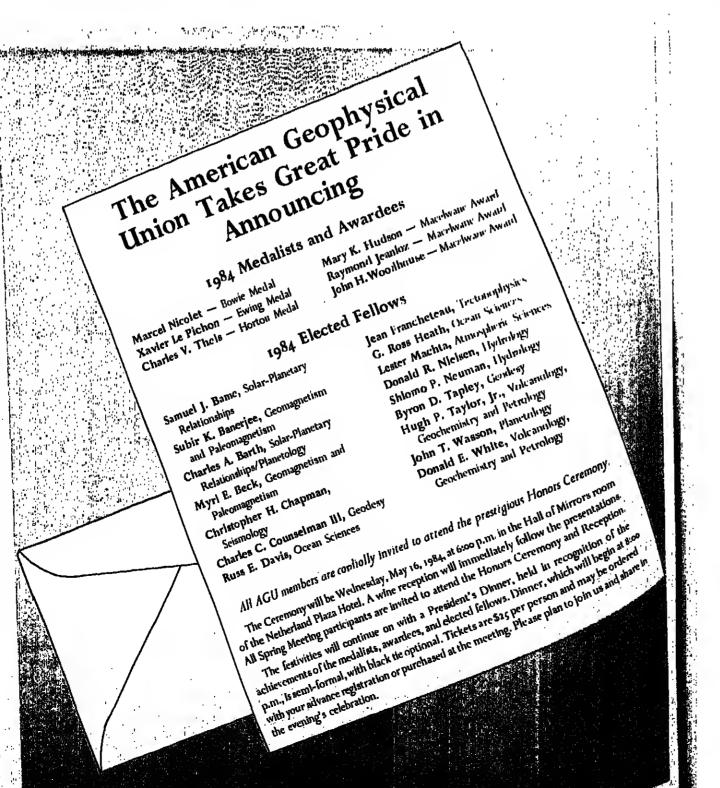
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Please Note: Reservations must be received by April 16 in order to be confirmed. All reservations received thereafter will be confirmed subject to

•			
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IMPORTANT NOTE: Hotel MA	Y require a deposit or	some other form of	Rifficulticed

arrival. If so, instructions will be on your confirmation form.



General GP, Mon PM Magnetic Strat. & Time Scales, Tues AM MAGSAT, Wed PM SV & Geodynamic Implications, Thurs

Paleomagnetism and Rock Magn., Mon

Geomagnetlam & Paleomagnetlsm

General Groundwater I, Mon AM G-W Transport Fiehl Methods, Mon PM Transport Processes I, Tues AM Mesoscale Precipitation I, Tues AM Transport Processes 11, Tues PM Mesoscale Precipitation 11, Tues PM Catchment Geochemistry, Weil AM General Groundwater II, Wed AM General Hydrology, Weil PM Hillslope Hydrology, Thurs AM Sediment Storage, Thurs PM

Occan Sciencea Ocean Drilling, Mon PM Ocean Response to Winds, Mon PM Physical Oceanography, Tues AM EM Fields, Tues PM Gulf Stream, Tues PM Straits and Sills, Weil AM Inland Seas, Wed AM Pelagic Sedimentation, Wed PM Gulf Of Maine, Wed PM Marine Chemistry and Geology, Thurs

El Niño, Thurs PM

Planetology
Lower Crustal Processes 1, Mon AM Lower Crustal Processes II, Mon PM Planets and Exospheres, Tues PM Planetary Posters, Wed AM

Selsmology Shallow Structurea, Mon AM Mantle Convection, Mon AM Rupture and Prediction, Mon PM Tomography and 3-D Problems, Tues AM Theoretical Seismology, Tues PM No. American Earthquakes, Wed AM Global, Regional, Volcanic, Wed PM Solid Earth Posters, Wed PM Honoring Bill Best 1, Thurs AM Structural Seismology II, Thuis PM Honoring Bill Best II, Thurs PM

SPR: Aeronomy Aurora-Airglow, Mon AM onosphere-Irregularitics, Mon l'M

Business Meetings and Section Luncheons

The AGU Council will meet Tuesday, May 15, at 5:30 P.M. The annual business meeting of the Union will follow the Council Meeting. Menthers are welcome

All section lunciteons will be held at the Clarion Hotel; room locations will be published in the April 17 issue of Eas. Please indicate on the registration form which luncheon you plan to attend and include

Monday, May 14

Geomagnetism and Poleomagnetism, \$7 Keith Runcorn, University of Newcustle, UK, will speak on "Lunar Magnetism." Sponsor: 2G Enterprises

Planetology!Voleamology, Geochemistry and Petrology, \$9.50

Tuesday, May 15

Selsmology, \$5 Lynn R. Sykes, LDGO, will speak on Seismological Research and the Nuclear Test Ban: The 25th Year." Sponsors: Kinemetrics, Inc.; Teledyne Industries, Inc.; and W.F. Sprengnether Instruments Co.,

Tectonophysics, \$9.50 Irwin I. Shapiro, Harvard Smithsonian Center for Astrophysics, will speak on tonophysics."

Wednesday, May 16 Hydrology, \$9.50

Oceon Sciences, \$9.50
Paul M. Wolff, NOS/NOAA, will speak on "New Direction for the National Ocean

Solar-Planetary Relationships, \$9,50 S. M. Krimigia, APL/JHU, will speak on "Priorides in Solar and Space Physics: Progress on the Current Academy Study."

Thursday, May 17 Atmospheric Sciences, \$9.30

Geodery, \$7 Arne Bjerhammar, Vlsiting Scientist at the National Geodetle Survey, will speak on "Einstein: An Early Surveyor (?)." Sponsor: Bell Aerospace and Textron.

Upper Atmosphere Waves, Tues PM Thermosphere-Exosphere, Wed AM Mid-Annosphere Transport, Wed PM Ionospheric Processes, Thurs AM Upper Aimosphere, Thurs AM

SPR: Cosmic Rays Solar Flare Parucles I, Wed AM Solar Flare Particles 11, Wed PM Cosmic-Ray Cutoff Rigidities, Thurs PM

SPR: Magnetospherie Physics Comet/Planet lonospheres, Mon AM lonosphere/Plasmasphere, Mon AM Project Westford, Mon PM Auroral Phenomena I, Mon PM Auroral Phenomena tl, Tues PM Particle Distributions, Tues PM Numerical Simulations, Tues PM Jupiter and Saturn, Wed AM Jonospheric Experiments, Wed AM Waves/Instabilities I, Wed PM Reconnection/Pulsations, Thurs AM Electric Currents/Fields, Thurs AM Aurora and Substorms, Thurs AM Distam Magnetotail, Thurs PM Waves/Instabilities 11, Thurs PM

SPR: Solar & Interplanetary Physica Solar Wind/Comets, Tues PM Shocks and Foreshocks, Tues PM Solar Physics, Thurs AM Upstream Waves/Particles, Thurs PM

Teetonophysica

Continental Tectonics I, Tues PM Mantle Convection and Processes, Mon Ridges and Fracture Zones, Tues AM Marine Tectonics, Tues PM Mineral Puint Defects, Tues PM Crustal Structure, Wed AM Geodesy and Tectonophysics, Wed PM Solid Earth Posters, Wed I'M Rocks Deformation, Wed PM California Tectonics, Wed PM Continental Extension, Thurs AM

Continental Tectonics 11, Thurs AM

Continental Tectonics 111, Thurs PM

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☐ ACSM-American Congress on Surveying and Mnpping

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Announcements

TAE Users Conference

May 1-2, 1984 Transpurtable Applications Executive (TAL) User's Conference. Greenbelt, Md. Sponsor, NASA Goddard Space Flight Center. [TAE Support Office, GSFC Code 933, Greenbelt, MD 20771; tel.: 301-344-6034.)

This public conference will feature discussion and demonstrations of the Transportable Applications Executive (TAE), a portable, standard computer/user interface whie! is now available for general use. The TAE program is a cummand and menu driven system that processes user input and sends it to an application program. It is used by NASA in large-scale meteorological analysis systems, image processing systems, and data hase man-agement systems. It is also used by universities and private influstry.

The users conference is being planned TAE users, who will offer live ilemonstrations of the program and how-to sessions on writing applications with TAE, workstation software development with TAE, porting TAE to UNIX, and many other topics.

American Geophysical Union

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sium on Relationships Between Climate of China and Global Climate—Past, Present, and Future, Peking, China. Spunsors, Academia Sinica, IAMAP, American Meteorological Society (Jih-Ping Chao, Institute of Atmospher-ic Physics, Academia Sinica, Beijing, China.) Deadline for abstracta is May 1, 1984. The goal of the symposium is to compare climate change in China with that of other regions in the world during the past, present. and future. The physical causes of similarities and differences will be discussed. Among the specific topics to be addressed are climatic fluctuations over the past 2000 years or more, air-sea interactions with particular reference to the west Pacific, land surface-climate interaction, and prediction methods for monthly and seasonal climate variations. The

Salt Lakes and Arid Zones

meeting language will he English.

September 24-28, 1984 SLEADS (Salt Lakes, Emporites, Acolian Deposits) Workshop on Genozoic Salt Lakes and Arid Zone Hydrology, Geochemistry, Stratigraphy, and Paleo-environments, Mathoura, New Sunth Wales, Australia. Sponsor, Australian National Univ.. (J. M. Bowler, Dept. of Biogeogra-phy and Geomorphology, Research School of Pacific Studies, Australian National Univ., GPO Box -1, Canberra 2001, Australia.) Registration deadline is May 1.

Contributed papers are invited on the subjects of salt lakes and arid zones, using Australian examples with comparisons from China, Africa, India, and the United States. The conference program will be divided into two general parts: regional, or site specific contri-butions; and thematic contributions drawing on information from multiple sites.

The meeting will be followed by a 2-10-3

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Meetings (cont. from p. 123)

day excursion through lakes and dunes of the Murray basin. The workship proceedings are planned for publication. SLEADS is a multidisciplinary research project directed toward study of climatic history, present and past hy-drology, geochemistry, birdogy, and geomerphic-tecupic evolution of late Centrate conti nental arid and sessi-arid environments.

The Geophyoleal Year calendar last appeared in the March 6, 1984, issue.

Meeting Report

Magnetic Reconnection

A Chapusan Conference on Magnetic Reconnection was held at the Los Alamos National Laboratory, October 3-7, 1983. More than 125 scientists. From more than a dozen countries, participated in the meeting, where fi2 scientific papers were presented and discussed. This report briefly reviews material presented at the conference after hist giving some background information on magnetic recundedinii.

In many interesting systems of magnetized plasmas, magnetic field lines can be divided into several classes on the lasis of their topological properties. One such system is skewheel in Figure 1. This represents earth's magnetosphere, enveloped in the flowing so-lar wind which is the earled by the interplanetary magnetic field (IMF). In this system hur closes of held lines are identified: (1) "rlosed" lield lines connected to earth at both emis, 12) "interplanetary" held lines that do not connect to earth at all, (3) "open" field lines connected to earth at one end and to the interplanetary lield at the other, and (4) "magnetic loops" that connect neither to earth nor to the interplanetary field. Surfaces called separatrires theavy lines in Figure 11 separate the regions of different topology (i.e., 2 from 3, 1 from 3, and 1 from 4), and these intersect or these upon themselves along lines called X lines (irrelicated at A. B. and C.

iu Figure 1). Figure 1 is adapted from a figure in the classic paper by, Dusgey, [19ii], who suggested that magnetic lield lines in the flowing solar wind "reconnect" with magnetic field lines of the eartls, in the manner shown, and that this process of "magnetic reconnection" accel erates the particles that cause the auroras. The reconsection process involves transport ing magnetic flux across separatrices from one region to another, and this is accomplished at the X lines. For example, an interplanetary field line (region 2), brought to the front of the magnetosphere by the solar wind, meets a closed line (region 1) at A. The two lines break where they touch at the X line and immediately reconnect to create two open field linet (region 3) that cunnect to the north and south polar caps of earth. Similarly, two open field liries, reconnecting at C, create an interplanetary field line and a closed field line. A closed field line, reconnecting at B, creates a magnetic loop (region 4) and a shorter closed line

Both the complexity and the importance of this process arise from the fact that in all cases of physical interest, magnetic field lines are closely compled to the mechanical behavior of plasma, so topological changes of the magnet-ic field must include transfer of plasma across separatrices as well. In fact, magnetic reconnection has been defined as the process whereby plasma flows across a surface that separates regions continuing to pologically dif-ferent magnetic field lines [Vas/finnas, 1975]. Topological changes of field lines thus imply definite patterns of plasma flow. They result, furthermore, in a conversion of magnetic en-

ergy to kinetic energy of the plasma. The study of reconnection had its origin in

sponsible for solar flares and the aurora, respectively, could be accelerated at X type magnetic neutral points. Support for these deas has been found in ever increasing num liers of thenretical and observational studies during the intervening years until, today, it is widely believed that magnetic reconnection indeed does explain the sudden large energy releases that characterize solar flares and in tense auroral brightenings called auroral or magnetospheric substorms. Furthermore reconnection has been found to play important roles in several areas of fusion research, and interest in it has arisen in relation to some astrophysical objects.

Despite providing conceptually satisfying explanations for phenomena in a variety of disciplines, the Idea of reconnection has face some skepticism, especially among students of the earth's magnetosphere. Thus, when particularly strong new evidence for reconnection emerged in recent years from satellite observations in the magnetosphere, it seemed appropriate for scientists of various discines and interested in reconnection to convene to hear about the new observations and to assess fully our present understanding of the phenomenon. That was the objective o the Los Alamos conference.

The technical program included six topical sessions of invited and contributed papers, ne poster session of papers on mixed topics, and a final session on Appraisals, Urranswered Questions, and Future Directions. The six topical sessions treated reconnection theory and modeling and the occurrence of reconnection in the laboratory, in earth's nagnetosphere, and in astronomical objects.

Theories and models of reconnection usu-

ally consider bodies of plasma that satisfy ide-MHD conditions such that the magnetic field can be considered "frozen" into the plasma, ti.e., moving with it). The actual recon-nection of field lines then occurs at a small region of the interface (called the diffusion region) around the X line, where localized breakdnwn of the frozen field condition occurs. Much discussion at the conference was devoted to examining the extent to which the reconnection process is controlled by externa boundary combitions, In one riew, favored by Axford, reconnection is controlled by exter nal furces that push differently oriented hells of topologically different regions to gether and dictate the heliavior of the field and plasma around the X line. Models of this process were discussed by Walker and Sato. who refer to it at "thiven" reconnection. [This should not be confused with "driven" magnetic substorms, a concept advanced by Akasofu in recent years, in which the reconnection process seems to play no role, or at least not a well-defined one.) In another view, favored, for example, by Schindler, the external effects are contidered to push the system to a configuration inherendy unstable. Reconnection then is initiated by the instability. In this picture, reconnection plays the decisive role in controlling magnetic topology and in releasing previously stored free energy. Because of its similarity with spontaneous phase transition processes, this picture is often referred to as "spontaneous reconnec-tion." Birn described three-dimensional computer modeling of the magnetotail that por-trays such a behavior and that has been ly successful in reproducing magnetic field and flow configurations actually ob-

serred during substo Data returned by NASA's ISEE I and ISEE 2 satellite pair, launched in 1977, has revolulionized our perception of the process of magnetie reconnection at the magnetopause (e.g., at A in Figure 1) and leave little doubt that reconnection is a significant process for energization of the magnetosphere. Sonnerup summarized the basic aspects of reconnection in the magnetopause setting, includ-ing the properties of rotational discontinuities, energization of particles in current layers, and the matter of nonsteady, localized econnection. Two quite different features in the ISEE data have been interpreted as signa-

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INTERPLANETARY MAGNETIC FIELD WIND SOLAR MAGNETOSPHERE DED 2 MAGNETOPAUSE. WIND

INTERPLANETARY MAGNETIC FIELD Fig. 1. A sketcls of the solar wind-magnetosphere plasma system. Black lines are magnetic field lines with likely arrows indicate plasma $\frac{1}{2}$ hetic field thes with mack arrows management that arrows mine arrows infine pasma bulk flow. The dashed line is the magnetupause, the boundary between the solar wind-dominated regime and the earth-dominated regime. The drawing is not to scale. Actual distances are earth (E) to $\Lambda = 10$ earth-tadii $|RE\rangle$ ($|RE\rangle = 6870$ km); E to $|RE\rangle = 15$ $|RE\rangle$ E to $|RE\rangle$ ~100 RE; magnetotril diameter ~40 RE.

3 19

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suggestions by Giovaneth [1948, 1947, 1948] and by Hoyle [1949] that charged particles re-SPRING MEETING, CINCINNATI, OHIO

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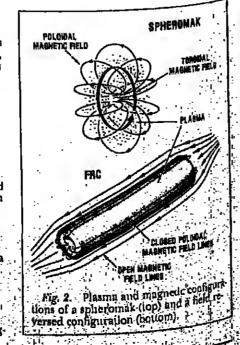
tores of magnetonause reconnection, and these have led to the present view that there ean be both quasi-steady reconnection and Impulsive, small-scale reconnection. Paschmann described the quantitative tests of tant-gential momentum balance of the plusma and ignetic field across the inagnetopause that led to the recognition of quasi-steady state reconnection. Tests of energy balance series the magnetopause were also consistent with the occurrence of reconnection but at a sumewhat poorer confidence level. Tracing the magnetic field topology at the magnetopause with energetic particles of magnetospheric orn, as described by Daly, has generally provided consistency cheeks with the data abtained from momentum balance. The rate and scale size of quasi-steady reconnection, as well as the precise onset conditions, cannot be determined from the ISEE data set. It has been noted, for example, that there have been numerous crossings of the sunward magnetopause when the triagnetosheath field was southward li.e., favorable for magnetopause reconnection as at A in Figure 11, and signatures of quasi-steady reconnection were, nevertheless, not identified.

The impulsive, small-scale type of reconnection was first recognized in a certain repeating pattern of magnetic variations seen in the magnetosheath just outside the magnetopause. The identification of these as instances of transport of magnetic flux [thus named flux transfer events or FTE's) was described by Russell. The interpretation is that spatially and temporally limited reconnection takes place near the sunward equatorial magnetopause and that the connected flux tube is dragged along the magnetopause by the ongoing magnetosheath plasma. Simultaneous ISEE I and ISEE 2 measurements of individual FTE's, described by Saunders, revealed that they have diameters of the order of 1 earth radius, the magnetic flux within them is ~5 x 106 Wb, and the internal field is twisted, implying field-aligned currents of a few times 10a A.. Rijnbeek and Berchem reported that FTE's are seen very frequendy (every few minutes) by a satellite located near the sunward magnetopause wheo the IMF is south-

Figure 1 shows two Xlines in the magneto-tail at locations B and C. That at C is sometimes referred to as the "distant neutral line" or the "quiet time neutral line." It is thought. lo be located ~100 to 200 RE from earth and to be present most of the time, jetting plasma and closed field lines earthward to maintain the plasma sheet of closed field lines (region 1). The leading substorm theory, often referred to as the neutral line model or the reconnection model, holds that at the onset of a substorm's expansive phase (marked by sudden intense brightening of polar auroras) a "near-earth neutral line" or "substorm neutral line" forms at B. This follows a preliminary interval (growth phase) of :-30 to 60 min during which magnetic energy (i.e., mag-

netic held littest is being added to the magneunail by reconnection with the IMF at A (Figure 1), leading in a stronger more ralial tail lickl. Recommention at II soon (in a lew minmes) severs the plasma sheet (the nightside region I failteard of ~ HCRE, transforming it into a system of closed lumps (i.e., region 4 grows by recommection mutil in completely absorbs that portion of region I tailward of B). This "plasmoid," completely detached from earth, theparts tailward, eventually to join the sular wind. Briefly, the model is characterised by a period (growth phase) of magnetitalleaerglation by interplanetary magnetic field (IMF) recommedion at the magnetopause, followed by a sprontaneously beginning period lexpansion phase) of "unloading" energy during which the tail rueray content decreases. The conference session on reconnection in the magnetotall reviewed the observe tions around which this model has been built

Much of the skepth isnt (memloned caree) raised against treatmeetion by students of the magnetosphere has been directed against the above reconnection model of substorus. Opening the conference session on reconneclion in the magnetotail, Nishida critically reviewed the evidence and mandereyher concluded that convincing observational bases for tail reconnection exist but emphasized that the physical nurchanism for it is not yet fully understand and that it is probably not the only important agent of tail plasma dynamics. Confusion and skepticism have arisen when people have tried to explain ery dynamical feature as due to reconnection and, Iniling to do so, have disconned there. connection model altagether. The evidence



for the onset of reconnection at expansive phase onter and the ensuing formation and departure of a plasmoid lies in observations, in the tail, of tailward plasma flow, southward turning of the magnetic field, tailward stseaming of energetic electrons, and plasma sheet drupout. Bieber reviewed these observations, and Nishida reported on electric field measurements, made by ISEE 1, that have also been recently added to the ocverall observation set that supports this picture of plasmoid formation and the neutral line model in general. The stretching and intensity increase of the tail field, which are two of the manifestations of tail energization during the growth phase, were described by Fairfield and D. N. Baker, as were observations indicating the loss of tail energy starting at expansive phase onset. Buth speakers also demonstrated that the growth of tail energy (growth phase) starts a lew minutes after the MF turns southward.

There is anuch observational evidence that energetic (up to ~1 MeV) protons and electrons are generated in the magnetosphere during substorms. They are seen in the magnetotad, and they are "injected" into the inner magnetosphere where they are observed at geosynchronous orbit $(r \approx 6.6 R_E)$ in conaction widt essentially every substorm. D. N. Baker discussed the energetic ion "drift echoes" observed at 6.6 RE and the "impul sive bursts" of ions seen in the magnetotail. both phenomena suggesting that the energet ic ion generation may be temporally confined to an interval of a few minutes around expansive phase onset. Scholer presented a general review of the extensive observations of energetic ions and electrons in the magnetosphere and noted that there have been comparatively few theoretical studies to explain them. Axford suggested that the particles may be accelerated as the plasma sheet is severed since magnetic reconnection may occur very rapidly then and cross-tail potentials as high as ~1 MeV might be expected to exist

NASA's ISEE 3 satellite made passes through the magnetotail as far as 220 R. from earth during 1982-1983, and several reports of those observations were presented at the conference. These reports contained dramatic new evidence supporting reconnection models of the magnetosphere in general and of substorms in particular. ISEE 3 found that the characteristic cross-sectional structure of the tail (i.e., north and south lides, separated by a plasma sheet) was recognizable at all distances examined. The flow of plasnta in the plasma sheet was almost always tailward and fast beyond ~100 Rg. Scholer and Daly reported that the plasma sheet also contains allward streaming energetic electrons and ions and that these actually extend above and below the plasma sheet. Cowley showed that all these featuret are consistent with un open magnetosphere with reconnection occurring at a neutral line earthward of ISEE 3. Gusling reported that the labe plasma density is often quite different on apposite tides of the plasma sheet and found that these differences showed a dependence on the IMF y component that is consistent with reconnection of the IMF with earth's field near the subsolar

magnetopause. D. N. Baker reported increases of the tail diameter at ISEE 3 concurrent with grnwth phase signatures at geosynchronous orbit and with southward IMF, suprting the picture of tail energization before orm expansion phases. Hones, Siscoe, and Scholer reported the occurrence of fast tailward moving plasma structures which they identified as plasmoids (i.e., severed plasma sheet sectors) reaching ISEE 3 about 30 min after expansion phase onset at earth (a delay priate for the earth-ISEE distance and the 500-1000 km/s flow speed measured in the passing plasmoids).

It is reasonable to expect that magnetic reconnection occurs in other magnetospheres as well as that of earth. Indeed, Behannon and Nishida reported observations of Jovian magnetoral fields and plasmas that can be interpreted as resulting from reconnection in Jupiter's magnetosphere. Niedner discussed comet tail disconnection events (DE's) that have been ascribed to magnetic reconnection at the comet's head when the polarity of the field draping the comet is reversed at 1MF sector boundaries. A few examples have been found of discontinuities in comet tail structure that may be due to tail reconnection,

similar to the substorm process at earth. Priest reported that our understanding of the sun's atmosphere has changed dramatically over the past 10 years. Our new view of the sun is dominated by the magnetic field and its relation with the plasma atmosphere in which magnetic reconnection plays a prime role. For example, the solar corona may be heated by turbulent reconnection, and reconnection may play several roles in solar flares. Parker stated that a universal feature of magnetized plasma is its activity (i.e., plasma turbulence and waves, shocks, superheated gases, and the production of fast particles) which occurs whenever and wherever a magnetic field in a tennous plasma is subject to exter-nally imposed strains. He also proposed that magnetic reconnection may be the central cause of the activity.

In the laboratory, several axisymmetric toroidal magnetic confinement experiments are presently being studied for controlled fusion. lagnetic reconnection plays a role in at least four of these. The tokamaks is presently the leading contender for development into a fusion power reactor, and in it the role of reconnection it detrimental to plasma confine ment. Paré discussed reconnection in tokamak and demonstrated its occurrence in the ISX-B device at the Oak Ridge National Lab-

In the reversed-field pinch (RFP) experi-ment, both royoidal and poloidal magnetic fields are externally applied and are of com-parable intensity, resulting in a very highly sheared held uplike that of the tokamak where the toroidal field taligned the long was around the torus) everywhere dominatet the poloidal field (aligned the short way around). D. A. Baker reported that the Lot Alamos 2T-40M experiment has maintained discharget at constant current and reversed field for 10 ms (much longer than predicted by calculations) possibly by energy transfer from the poloidal field to the toroidal field by steady state reconnectium of the mean fields.

The Field Reversed Configuration (FRC) and the spheromak were discussed by Milrov and by Hammer, respectively. These devices are members of the "Compact Torus" family f magnetic structures characterized by a set of closed, nested flux surfaces but without any coils, transformer cores, etc., protruding through the hole in the torus. Their magnetic configurations are shown in Figure 2. The formation of both involves tragnetic reconnection. Spheromaks have been formed successfully in several different ways. In euch case, during a "preformation stage," poloidal field lines are wrapped around (or penetrate) solid bodies. During formation, plasma is created, and the toroidal component of the field is introduced. Magnetic forces cause the flux surfaces to distort and eventually reconnect to form the desired set of closed, nested surfaces sketched at the top of Figure 2. FRC's are formed in a field-reversed 8-pinch as follows: [1] an initial reverse bias field is frozen into a cold pre-ionized plasma; (2) the current in the 0-pinch coil is quickly reversed. producing a large forward bias held, which causes the plasma to implode radially: (8) the oppositely directed field lines reconnect near the 0-pinch ends forming a closed field con-

figuration such as is sketched at the hottom of Figure 2. In summary, the conference exposed many interested scientists to discussions of present thinking about magnetic reconnection and to descriptions of the latest developments concerning reconnection in space and laboratory plasmas. Most of the formal presentations as well as the discussion of them by the participants will a pear appear in AGU the Geophysiral Monograph Senes, vol. 30, Magnetic Reconnection in Space and Laboratory Plannas, to be available at the 1984 AGU Spring Meeting in Cincinnati

Cosponsors of the conference, along with the American Geophysical Union and Los Alamos National Laboratory, were the U.S. Department of Energy, the Institute of Geophysics and Planetary Physics of the University of California, NASA, and the National Science Foundation.

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Giovanelli, R. G., Chromospherie Hares, Mon. Not. R. Adron. Soc., 108, 163, 1948. Hoyle, F., Some Recent Researches in Solar Phys its, Cambridge University Press, New York,

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This meeting report was contributed by Edward W. Hones, Jr., University of Culifornia, Los Alamos National Laboratory, Los Alamos, NAI

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> Deadiine: April 30, 1984

Hiring, Firing, and **Job Security**

AGU Spring Meeting Tuesday, May 15 5:15 - 7:15 P.M. Ivory B Room . The Clarlon

This panal discussion of current practicas in employment of geophysicisis in a wida ranga of areas (ecadamia, industry and government) will include who gais hired, how to stay hired and possibilities of firing, as sean from the employer's point of view, Lauria Brown, Visiting Associate Proleasor, Department of Geoscience, New Mexico Institute ol Mining and Technology, will modarete the discussion.

This program has been erranged by the AGU Education and Human Rasourcas Committaa. Rafrashmants will be evallable.

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Aeronomy

0410 Absorption and Scattering of Endiation
PRITODISSOCIATION of 160180 IN THE ATMOSPHERS
A.J. Slake (Department of Physics, University of
Melitde, Adolaide, Routh Americale 5000, Americale),
S.T. Gibson and O.G. McGoy.
Although 150180 is minot constituent of the
Cheaphers, its photodicsociation rate has been estated
to be significant because of selective absorption to
the region of the Schumson-Runge bands, as a result of
instable effects in the spectrum. To is important to
daterates the contribution of shie species to the total
dissociation rate. Calculations of the 16000
dissociation rate. Calculations of the 16000
discociation rate. dissociation rate. Calculations of the 1f0100 dissociation rate conflicted [J₂] seleg a detailed like-by-lus model of the cross-section in the band system rewest is in of the order of 10 cimes the discociation rate conflicted for 150 [J₂]. The total 150150 direction rate contributes a maximum of March 150150 direction rate contributes a maximum of March 150150 directions estimate. Theoretical vectors of the spectroscopic constant for 150150 ere given [J₂0150], absorption, Schumann-Rungs, dissociation J. Coophye. Ros., O, Paper 400403

DAJO Aeronomy (Composition).

AV INTERCOMPARISON OF SAGE AND SBUN OZONE OBSERVATIONS
FOR MARCH AND APRIL, 1979
O. H. Channold (School of Seophymical Sciences, Georgie
incitives of Ischnology, Aliesta, Georgie, 30322), M. C.
Pilis and C. R. Tropie
30 latitudinal cross sections of siretospheric oione
obcorved by the SAGE and SSUV setallite Indiruments on
the same days to March and April 1979 and al appropriately the some latitude are compared. Alfrerenced is
zonel made mixing rollos are discussed. The largest

differences are tound at pressures lower than S mP at tropical letitudes where the SAGE ozone mixing ratios are approximately 20% lorger than the 180V mixing ratios. The longitudinol vertations of ozone over this puriod inferred from the two instruments are discussed to detail and correlated with each other and with IROS-N temperature observations. The SAGE measurement enis model is shown to be approximately tomelyted with the observed differences in longitudinal structure. It is found that, on the average, the amplitude of observed ozone vertations inthis eventical exist acceding 3 km) is similar in the two supertments but that this amplitude or to is dependent on the abmospheric Situation. Osophys. Res., D. Paper 400317

Electromagnetics

0750 Scattering A Time-scrain Energy TREORES FOR SCATTERING OF PLANE OTSO Scattering
A TINFICATH ENERGY TREARCH PUR SCATIFFIED OF PLANE
ELECTROMADED TIC MAYES
A.I. de Hoop Dulit Priveralty of Vechnology, Dept. of
Electrical Faginos'ing, Laboretary of Electromagnetic
Ruswarch, P.O. Sty. 5031, 2600 GA Paift, The Northerlands)
A time-domain energy theorem for the scattering of
plane electromagnetic waves by an obstacle of bounded
extent is derived. It is the counterpart in the time
domain of the 'aprical theorem' or the 'extinction
cross socion theorem' in the traquency domain. No
escamptions set to the electromagnetic heavier of the
obstacle meed to Pa mode; so, the obstacle may Pe
electromagnetically non-linear and/or the verleat is
kind of behavior size in varieded in the frequencydomain result! As to the wave motion, three dillorant
blads of time phastler are distinguished; (A) transient,
10) periodic, and (C) perpetuation, but with fielro mean
power flow density. For all three cases the total energy
icase (Ai) of the time-special power icases (B) and
IC)) that is both shorbed and scattered by the obstacle
reflected to e cattain lime febracism lategral of the
lecidont plane wave and the spherical-wave amplitude of
the scottored wave in the lear-liaid region, when
observed in the affraction of propagation of the incident
wave. The practical implications of the sortsy theorem
over Privily indicated. (Thes-domain scattering,
Electromagnetic theory! Electromagnetic theoryl.

Exploration Geophysics

John Halpenny Barth Physics Ernoth, I Observatory trescent, Otiva, Ont., Geneda Eld 2011 research, Otiva, Ont., Geneda Eld 2011 research, Otter on the season of the gastenny of the grant of the gastenny of the cartesia of the gastenny of the cartesia of the gastenny of the gastenny

recognized and removed, and creps or allests are identified and presured. An example is shown of cless output produced from input which suffers from a veriety of instrumental profices.

8920 Magnetic and electrical methods OPPSHORE ELECTRICAL EXPLORATION OF MEDITHERTARY HASHES: THE EFFECTS OF ANGEOTROPY IN HOMIZORTALLY ESOTROPIC, S.R. Edwards LDegartment of Physics, University ol Tarono, Taronto, Ont., Canada Mis IA); O.C. Nobos, B.

Torono, Torono, one, semantics in the constant of the constant of the constant of a long, vertical, Pipolar ac source, estanting downstant from the sea curface to the bottom of the sea and a remote, and apaulated,

and transmitter-augmetomater superations.
At the low-frequency scatic limit, apparent resistivity curves, shulter to atenderd Schlumberger resistivity containing curves, are constructed as an eld in the direct interpretation of least-opic crosses resistivity. As intermediate relatively resistivity as caused or relatively resistivity. crammitter-receiver appearation extends the order of twice the dapth to the cone. The physical grapherty resolved Py the mathod in an anisotropic crust, which has different horizontal and vertical resistivities, is has different horizontal and vertical resistivities, in the geometric mean of the two independent real stivities. The thickness of a layer is indotermineto. A tayer with a coallicient of amsotropy / responds like an isotropic layer / times thickness. At higher frequencies, when induction in the see water is significant, the apparent annuction in the sou when is significant, the apparent resiteivite turves result valid provided locally indured current flow does not dominate the galvanic flow in the crustal setetial bocouth the son, The greeners of some locally induced current, at the electromagnetic resistive limit, is advontageous, it employed the coafficient of enlentrapy of an enlentrapic case to be determined jointly with the mean resistivity. An approximate direct scheme involves the calculation of the apparent enlentrapy, p formula which, like the apparent resistivity formula, is a bunclion only difficient apparent resistivity formula, is a bunclion only difficient apparent resistivity formula, is a bunclion only difficient apparent per massured engostis field and the transmitted course.

current.
The depth of penetration and the resolution of mean realistivity and enisotropy are presented in terms of Frechat larnels and resolving hernels. The kernels are manylic for the special case of a uniform court. The chapes of the Prachet hernels for resistiving and unicolropy are different. At low frequency, this reliects the different Peheviors of the gasvenit

grouging is introduced into both lorward and inverse computer significations when the resolving hernels about a given depth are wider than the inichness of a typical GEOPHYEICS, VOL. 49, NO. 5

ACCURACY OF PINTTE-DIFFERENCE APP PINITE-BLENERT MODELING OF THE SCALAR AND ELASTIC WAVE EQUATIONS

MORELINO OF THE SCALAR AND KLASTIC WAVE EQUATIONS
ENTS), Martice IAssoc Production Conputy, P.O. Box \$91,
Tules, OR 74102)

Burgical nofutions of the scalar and siestic wave
equations have greatly sidef geophysiciate in both
forward modeling and migration of selemic wave (leids in
compileated geologic models, and they promise to be
invaluable in solving the full inverse problem. This
paper quantitatively compares finite-difference and
finite-minemen solvitons of the scalar and sinstic
byparbolic wave equations of the scalar and sinstic
tackelques.

techniques.

In addition so verentility and came of implementation, is is importative that one choose the most cost-effective solution technique for a fixed degree of accuracy. To be of value, a solution technique quet be able to minister (!) numerical attenuation or amplification, (2) polarization ercore, til numerical anisotrony, 141 polarization of the proof of th

and scattering, and (7) ecrors in reflection and translation unefficients.

This paper shows that in homogeneous medic the explicts finite-element and linite-difference schemes are compared to then solving the static wave equations with Poleson's ratio less than 0.5. Static relaments are superior to linite-differences when modeling static as active with Poleson's ratio between 0.5 eth 0.63. Por boat the scalar and ristic squarione, the mode costly implicit cinpicting electic squarione, the mode costly implicit cinpicting electic squarione, the mode costly implicit cinpicting election schemes such as the Savmark Schemo are inferior to the oxplicit concere-difference echaes, since time expc surpacsing the Courset Condition yield achie but highly inaccurate results. Frequency-domain finite-element solutions employing a weighted everego of consistent and imped cases a yield the most accurate results, and they promise to be the most cont-effective method for COP, well log, and interactive modelles.

0930 Selectic methods A CASE STUDY OF STRATIGRAPHIC INTERPRETATION UNIVERSELECTIONAL REFERED DATE

M.O. McCormach 1ARCO Oll and Gas Compact, P.O. Gos 2519, Dallas, TR. 755215 J.A. Dambar, and W.V. Sherp This paper describes the upe of surface recorded compressioned and horizonsel wherewere selected date to detect leteral changes in the physical properties of a cleatic unit, Sheer and companies of each transit times vers'measured across a selected interval (com CDP struked sections derived from dess collected along atputed sections darined from dess collected along colocidant sheer and temperational sejected lines. At eath exclese pasision the read of the shour-to-compressional transit time served the farget horizon is calculated, it is shown thes leteral weightless to the rests coupled with the behavior of the fodividual transit time turves, and be oped to lose

changer in the physical properties of a formation.

The borizon selected for this case study was the lower Fonnsylvales Norrow formal on which produces gas from channel and bodies at the Empire Abo Ifeld, Ray Mexico. A detailed geologic section of the producing horizon was supped along a setucic line original so that it crossed productive and monproductive regions of the field, dhear and compressional vibrosefs aureaus were conducted sions this surface profile using data acquisition parameters day lighed to produce comparable signal-to-noise ratios and resolution in both sets of field data. After processing, the snear and compressional retail reproductive to the snear and compressional interval transit times through the Sorray forms to decreased in going face composite thicknesses of sand. Furthermore there is a graphic to the compressional transit line vasualing in an averall decrease in the ratio of shear so compressional transit times. While seward possible physical changes in the larval properties of the reservoir could explain these observations, it is concluded that the priesty sections are such of the reservoir could explain these observations, it is concluded that the priesty sections are such others as a variation in the mand-shele ratio within the Sorrow towards. As, 50, 5

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A revitorational LT Past APPROach to MATfaun-Likelishood Was or Resour. See., Paper 340175
Dicomposition

Stora AT Hits! Laitus!

(Center for Earth and Clansiary Physics, Harward

"hiserthe, 29 Outnot St., Carbridge, MA 021364,

E. Ross and M.S. Willroy

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present lead of Variospheric Co., Flurivations in
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may account for the afpassent control on citrate sacrels
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J. Geophys. Rose. 6, Papes 400315

Geodesy and Gravity

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CAPP DILECTION OF TIME-DEPENDENT STRUCTION AT DEPTH

J. Betwee (Lamost-Ochesty Ctofoglosi Chestvalory of
Columbia University, falleden, how York 1944), S.
Silme and S. Berril

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Geomagnetism and Paleomagnetism

2598 General
STATISTICAL TOOLS FOR THE ANALYSIS OF GENERAL PROFESSAL SEQUENCES
F.L. NCFASSAL SEQUENCES
F.L NCFASSAL SEQU

GapyTricks, vol. 48, 50, 3

Osio Selanic methods
SPARATION OF S-WATE AND F-WANE REPLECTIONS OFFShork
Resistary FORNINA
Robert H. Tai ham ifectioned inc., 0008 av Presway, P.O.

Berd vaier-botion mastes onvironments, such as
of fabore weatern Florida, have presented particular
problems in the acquisition and processing of salamic
reflection data. One problems has been the limit of engine
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Breat camp for problem has been the limit of engine
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A THUTCHAILT PAST APPROACH TO MAXIAUR-LIREISAND
DICOVOCUTION
Chartering Ch. Lifer Proposition Laboratory, California
finalitate at Technology, 6000 Onk Grow Grive, Pasadeas,
Ch. 91697 Ferry M. Maniel and Sen Nappon
In this paper we derive and templement a
danuar-libelishoof dromeolution (MD) algorithm, beset
with the same channel and what sisted models used by
Europia and Mendel [1981a], that leads to many fewer
compitations than their MO algorithm in a sist algorithm and in a sist algorithm and in a sist of the parameters, delect invalidate
and statistical parameters, delect invalidate
Corr MD algorithm is implemented by a two-phase block
companent method (EC). The phase-1 block lunctions like
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and of good initial cocistions for the phase-2 block,
which functions like a fine adjustment of unbower
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Geochemistry

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strong for the past 1300 years, when all the componitor of the provides and the past prov fration, fre cores, sisciology)

ev. Ceophys. Space Phys., Paper 4F01Po

3150 Frecipitation THE DISTRIBUTION OF CATCHARM YOUR AGE OF STAYLORARY

THE DISTRIBUTION OF CATCHANGE TYPERAGE OF STAYIONARY PAISTONS
Pers 3. Englance Compariment by Yivis Engineering,
Nassachusets Institute of Tachnology, Yambridge, Hassachusets 103139)
The occurrence of wetted respectors are which a castchaset is modelled as a Fotence artifus process in which each storm is compound of similarity, non-controlled the sack storm is compound of similarity non-controlled to the sack of the controlled sack storm is compound to similarity, non-controlled sack storm is compound to sack whose cream are fractals. The two Palsace is space and whose cream are fractals. The two Palsace parameters and hones the flist two contents of its wested firstice and derived in the terms of calchaser-awates observed resisting of the jubservable) stair on precipitation. The model is used to sailbare spatial properious of tropical sic mass thunderal orce on ain tropical creathers in the Sudan.

Valus Sacouc. See, faper 400007

3180 Water Quality [Surrient Loading) STRATICRAPSIC EVICENCE OF EUTROPHICATION IN AM

STARTICEPSEC EVIOLEC OF EUTEDFRICATION IN AN ESTUARY
G. S. Srush (Ospertornt of Geography and Euvironemist Engineering, Johns Rophies University, Saltitors, Maryland 21218)
Verited thanges in chlorophyll degredation products proserved in sediments deposited in me urban estuory show a significant increase in significant increase in significant increase in every sediment of severge efficient into the civer. By tooperison, significant induction during futurative agriculture of the waistabed, including heavy applications of fertilities, was insee by an order of meetings where iteis, was ines by an order of megaliude where there was no savege distherge from a point source, Yeastmiretfone of orthephasphorus correspond with continietions of signi coffs and chlorophyli in

Journal of Geophysicsi Research

J. K. Dienes 2508

Volume 89 Number 84 April 10, 1984 Sin-Nd and Rb Sr Systematics in Volcanics and Ultianistic Xenoliths From Malaite, Solomos Islands, and the Nature of the Unions July Plateau (Paper 3H1929) Of the Cistory Jack Philessi (Paper 381929)

An Extensive Region of Diff-Ridge Normal-Faulting Enthquaker (a the Southern Indian Oceas (Paper 381911)

Constraints on Plate Middans in Southern Pakistas and the Northerts Alabian Sea From the Focal Mechanisms of South Indian Control Mechanisms of S

Richard C. Quittery and Alus L. Kufka 2444

Pocal Mechanisms and Depths of Furthquakas in Central Pakittan: A Tectonic Interpretation (Paper 1815)21

Richard C. Quitteryer, Alua L. Kufka, and John G. Atmbrutter 2459

Regional Deformalies Near Pulmdale, Catifornia, 1973-1983 (Paper 981876) Geodetic Studies in Baja L'alifornia, Mealco, and the Evaluation of Short-Range Date From 1974 to 1982 (Paper 191398)

Geodetic Studies in Baja L'aliturous, meanter, end annual de la 1974 (n. 1982 (Paper 3B1996))

Desmond Darby, J. Javier Gonzales, and Philippe Lasage
Rapid Discrimiosism of Cirantine Rock Campositoris by Low-Resolution Near-Infrared Reflectance (Paper 3B1927)

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Afec K. Bulsd

2491 Comments on "An lettere Approach to Signal Correlation" by D. G. Martinson, W. Menke, and
P. Stoffe 1Paper 4800191

Lates Share and Alan O. Chave 2497 Reply (Paper 4B0015) Douglet G. Martinson, William Menke, and Paul Stoffe 2501

1. K. Disnes (Paper 331704) James R. Rice 2505

Reply (Paper 3B19111 Correction to "Travel Time Analysis of Borehold Seismic Data" by R. A. Stephen and A. J. Harding [Paper 4B0096] the meter column, and are greater by an older of magnitude where sewage is discharged into an agent of the column of the sewage. The response of the setury desiring so urban-agaicultural watershell, the seture to sewage. The response of the seture; to short- and long-ture thenges in the sewage discharged is reflected by alwing thenges in chierophyli production. However, chlorophyli production does not correspond with increases in the gnount of fettilizers uncl in result years over the amount used in the nil to late 15th tentury. Includely, sewage, lortilizers, chlorophyli production) water Resour. Red., AMOUSI

Meteorology

f720 Climatology
ON THE ESTERNIMANTS OF THE MEAR SURFACE TIMPERATORN
RIGHE OF THE SOUTH FOLAY PLATEAU
J. J. Carvoli (Copariment of land, Air and Water
Resources, University of California, Savis, California

ALGINE OF THE SUBTR FOLKS, TAILED A.

J. J. Carvoll (Coparisant of land, Air and Water Resources, University of California, Savis, falifornia 9581b)

Most sindies of the physical climatology of the Antarctic interior focus on the local surface anerty bedget. The results of those studies are reviewed leading to the ulten cited conclusion that at omember there received reading to the ulten cited conclusion that at omember the conclusion that at omember the transfer the surface of the interior plates. Hieropoteorial gital data taken over a 1 year price of the current of th

3745 Cravity waves
COMMENT ON "ON POTENTIAL WELL TREATMENT FOR
ATMOSPHERIC GRAVITY WAVES" BY L. YU et al, AND
"A OISPERSION FORWILA FOR ANALYZING "MODAL
INTERPERENCE" AWONG GUIDED AND FREE GRAVITY
MAYE MODES AND OTHER PHEMOLENA IN A REALISTIC
ATMOSPHERE" BY T. P. TUAN AND D. TADIC
C. O. Hlags (15 Henry Street, Teronto M5TIW).
Canada)

Canada)
Attention is drawn to an unfortunate and
potentially misleading support of the choiced
of gravity-ways 'petential' ampleyed in the
cited articles, and an alternative choice is recommendad. J. Geophya. Rea., A, Peper AR0268

Mineralogy, Petrology, and Crystal Chemistry

J. Geophys. Res., B, Pager 40011b

A220 Descriptive minoralogy AN MUNICAL TYTANTUS-SICH SIMEMAL FPUH OSID, MOSMAT T. V. Logaistad Inincratoglical-Goological Museum, University of Oxido, Case yate 1. Oxido A. Marenayi An unusual Titulich oxide mineral of composition from the menantage albities dibe at oxido. Norwey. The mineral is metamic because of a small Th contont, and contains shunders water till-14 ty.4. It is black with a matallic to ademantine lusaer and gives a black-brown streat. The Moha bardoses is 6. The rollectivity in 17.0-11.4 4 1540 nml in air, weakly enisotropic. Heating in air or nitrogen gives x-ray pouder times of ruttle 1700, 800, and 900°Cl or brannerice (1806 and 1806°Cl. The checkstry of the mineral resembles that of crichientie. (Ti-ningral, crichionite).

GEOCREHICAL SVOLUTION OF THE HEMBINGAL CALDERA

P.T. Last | Dept. of Environmental Sciences, University of Lancasist, V.S.), R. Macdonald and R.L. Selb.

The persikaling trachytic volcane Headings ban R.1. Seith

The peralkalins irachytic voicann Renougal has
bad a complex genhould voicann Renougal has
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the laistplay of magan mining, crystol fractionalisa
and liquid-state differentiation. Prior to a major
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scompenied expition of a sacond sheflow sheet,
also compositionally sound. This was followed by
convertive overture within the magan thember and
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a level not capped by the sah-flow. Sidewali
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acoustions brough thicknesses in scene of 10² to (in
times of 10² - 10³ years.
J. Seophys. Sme., B, Paper Abb305

Oceanography

OCCAROGRAPHY

4713 Chromation

STASSPAL VARIABLETY IN MEANMARS OF THE

CALIFORNIA SUBLECT SYSTEM OFF VANCOURSE ISLAND

In the la Department of Commongraphy, University
of Stitish Columbia, Veccouver, S.G. VSC 18F1 W.

J. Bary and L. S. Hyank

Gastilite inferred images takes over the past
few years cavest assessed veristics in the
mendars of the Carlifornia Current System (CCM)
off Vancouver Island. The CCS southbits meandars
with invested the between 125 and 135 few in both
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all flows corthwestered or moutheastered,
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northwestward beausth the southeastered mirror
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APS Surface usuas tides, and see lever
BRATISH AND TENDORAL TRANSFORMATION OF SRALLOW WATE
WAYS EMERGY
Sestithorn Aranuvechapun and Sdward B Thornson
Department of Orsanography, Naval Fosigradusts School,
Montatry, California, 95945)
The swafeous ware apactra from the Alfantic Orsan
Remola Sensing Land-Orsano Experiment (AREUR) during
the passegs of a 25 heart storm, were subjected to an
capitical alganiumction enalysis. Results from the
capitical alganiumction enalysis. Results from the
mealysis are interpreted as the spetial and tracord
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despace werer into the abeliaw region where by thing
finely occurs. The immporate variation is loosd to
be approximately 7-172 of the total variance in the
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2-5 osciliations which appear correlated with the
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Particles and Fields-Interplanetary Space

5340 Shock meyes SPECTRAL ANALTSIS OF MACHETOHYDRODYRAMIC PLECTIATION SPECTRAL AMAITSI OF HADNETONYRADYRADYRAMIC FIRSTURY
HEAR INTERPLANETARY SHOCKS
A. F. 918ms (HASA/Godderd Space PSIGN Content
Lab. for Extraterrestrial Physics, Grackell. In
2077) M. L. Goldstein and M. H. Acuma.
Svideous for the pecannor of refatirly irraspitade right-head stiptically polarized 300 evrispitade right-head stiptically polarized 300 evriforward sad ravarus leterplanetary shocks in France
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Figurusoles The observed spettra have a high figures. frequencies. The observed spectra have a sign frequent dependence of f. 2.5 to f. A peculist lattered to leave the same latter of the leave the latter of the latter dependence of f. 2.5 to f. 4 peculiar laterage is dependence of f. 2.5 to f. 4 peculiar laterage is test node identification is on event is the last correlation observed between 18; and proton the for field aligned propagation. This appears the nonlidear affect, second order in the year satisfied in monificate affect, second order in the year satisfied the propagation of the word cannot interest of the electromagnetic inpropolation intallifeters of the electromagnetic inpropolation in administration and in containing the considered to eccount for the polarization of an expectation of the observed finite containing in administration of the solar wind proton electromagnetic for the observed in the solar wind proton electromagnetic for the observed in the solar wind proton electromagnetic for the period of the containing the period of the containing the period of the period of the observed in the solar wind proton electromagnetic for the period of the perio

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power SPECTRAL SIGNATURES OF INTERPLANETARY CORNTATING
AND TRANSIBAT FIGURE
M. L. Goldstein [MASA/Sodderd Spatz Flight Center, tab.
for Extraterraturial Thyaica, Code 891, Grossbeit, MD
SOFIL), L. F. Euriage and W. S. Matthews
Russet studies of the time behavior of the galactic
sensic rey intentity have concluded that long term
decresses in the intensity are generally associated with
syntose of fatesplantary flows that toniain flare
generated shook waves, Empartic clouds and other
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power apactral algustumes of such flow systems are
computed to power spectra obtained during times when the
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color wind a dominated by atable coronising atreams
that do not usually produce long-lived reductions in the
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fastures of these tout types of regimes framited and
coronising) are difficult. However, the distinguishing
fastures are not the seem throughout the ballomphere.
The transient flows at 1 AU tond to have smaller
sorrelation longths and larger magnatic holicity scale
langthe them do the aproacting flows. In data collected
byood 1 AU, the primary differences are in the power
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than to the power to the field components. Consequentity, decreases in tossic tay intensity are very libely
due to magnatic alsors forces and graduat drifts rather
than to pfich-angle acattering. (magnatic itelds,
plaress, SED turbulence, cometer raye)
d. Ecophys. Xee., A, Yaper 4A0f38

5580 Wave propagation PROH THE POLAR ELECTROJET AN-

5120 Floctvio fields
10009PMERIC REATER BEAM BCARMISC; A NEW TECHNIQUE POP
ELF STUDIES OF THE AMERICAL 1000SPMEPS
K.T. Riesvald (Mar-Planck-Institut für Assoncole,
D-Mif Katlanburg-Lindau, Fadora) Republic of Germany;
R. Bert, S. Kopke, E. Nielsen, P. Stubbe and R.L.
Dowles R. Serr, S. Kopks, E. Nielsen, P. Stubbe and R.L. Dordso

E.F/TLP wave generation by modulation of the surgeof alactrojet has previously been performed near Promes, Sorway with a EF having bases pointed in a timed senith direction. By varying the phases of the HP waves trenslited from adjacent save of sottennes in the transsitude of the morth-south place at Irequencies from sero to approximately 5 kBs. In one type of been scanning the amplitude of the beacker been in ELF modulated while the beam direction in a service of the morth-south place at Irequencies from service and direction in a simulanceously supplicated while in the senith applitude of the beacker beam in ELF modulated while service in the same are above to be associated with privial variations of the surgent lemosphere in the north south direction. We compare these spatial variations without observed by ELARS. IELF/VLF waves, ionespharic heating, electric fleids).

Bed. Sal., Paper 450344

Particles and Fields-

Ionosphere

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Replet Fracking apparlment was performed to the
Reverd-Satthsonian Center for Astrophysics on the
eccasion of the 1915 Apollo-Sovas Heat Project (ANT).
The data are analyzed here for Integularities in
electron density at the altitude of 212 No. The
differential Reppior data with the relative socion
two rescond are integrated to educin a representation
of the electron density variation along its satellite
path. Sell-known large-scale freatures such as the
opostorial geomographic anomaly and dayforthell lunication
level differences are clearly observed in the integrated data. The larger crust of the menting econogmetic anomaly is seen to pour in the acuthon indiction
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5545 Ionospherit disturbances CREMISTRY AND SYNAMICS OF SF INJECTIONS INTO THE CREMISTRY AND DYNAMICS OF SF, INJECTIONS INTO THE FREGION

5. A. Jethardi IAIMERSpheric Sciences Croup, Los Alamos Fartosal Laboratory, Los Alamos, EM 87545)

The threaderty of SF, vapor searching in the F-region is critically examined. The SF, molecule dissociatively extendes an electron producing the SF, ion. Searches between an arbient of lon and the SF; yields thing a neutralization. During the noutralization process. 20 electronically excited oxygen stone, 01(0), any he produced which will subsequently emit a bf0.0 nm photon. A release of 20 kg of SF, into an eathern 0' los concentration of 105 cm⁻³ at 300 km stitude is concentration of 105 cm⁻³ at 300 km stitude is concidered. The 860.0 nm airgion intensity may increase Yellewing the release. The megative ion places to allow to be marginally unstable to a gradient fift instability.

3. Coophys. Kas., A, Popor 1,00407

5545 lonespheric disturbences THE DISTRIBUTION OF TOPSION SYREAD-Y IN ALTU MEASUREMENTS BY DHEP-12 AND PA E.S. Topsg (Regis College Remearch Contor, Weston, NA, 02193)

Particles and Fields—

Nagnetosphere

Grophysics Laboracory, apars Physics Ofvision, Energo AF, MA (1179)

On the basis of 551 equatorial peases of 1859 at 840 in, we have detartioned that two distinct types of top-side los deplactions occur to the evening sector during equinoctial periods. Firstly, during the seril average probability of observetion per pass. This feeture as aligned parallel to the aspectic squaret and probability of observetion per pass. This feeture is aligned parallel to the aspectic squaret and an irregular deplactions cannot be average from a form the topside signatures of spread-P. Their total probability of occurrance per pass i orrespect from the first total probability of occurrance per pass i orrespect from the first total probability of occurrance per pass i orrespect from the first data than that appead and parallel of the second of the secon

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Devid A. Hardy (Space Physics Division, Air Force Geometric Attentions and Association, Henseco AFS, Managachisects 01731)
A systematic survey we performed to desermine the Yesquency of occurrance of incames fluxes of clastrous above the Level of the polar cean at geometric latitudes 2 85° and their reinitpoship to the orientation of the incarplementry memetric Field, the density and felocity of the solar wind and geometric activity. These interpretations will dentify as the "pofer shower" and "polar equalis" reported by Winninghem and Heltils Siff; zecame on the DMSP F2 services of data from the Siff; zecame on the DMSP F2 service of data from the sifice amiented natisfied the culture has been able to the the service and that mera avaitable both for the hour in which the smilling pages over the northern headsphere is that in 30% of the cames pruised an alertron, Ylux according the layer of the polar rate wee food to both headsphages of according the according the pages of according the according the according the according the precious of the service according the pages of according the according the pages of according the according the according the pages of according the page Le ther in NOR of the came youlisd on electron you according the laval of the polar rate was food to both hemispheres & geomegacate initudes > 85° and that each occurrences are dependent preodulently if not exclusively on the He component of the He being ratio as the late of the He being ratio as the late of the He being rates of the De He secondary of the He being rates of the De He secondary appears to be both a markesory and sufficient coolition for the open recent of late flux shorts 88° admensatic latitude. Occurrence la independent of the Life Be god He component. The occurrence 2s strongly should toward Ep = 0 but an occurrence accepting 387 is food up to a Sp = 4.

coincides with the observed range of frequencies. (AND waves, allocisosapports indexpelored inde

5500 sparticle Procipitation)
FMERGETIC OFFGIRS IN A MID-LATTING ANDORA

N. S. Torr (Wish State University, Department of Physics, URC 41, Logan, Wish 84112), Department of Physics, URC 41, Logan, Wish 84112), D. C. lorr on the hight of Suptember 9/10, 1082, groundhamed observations were made of an aurora which gained a larging spectrostor was used to obtain spectral images over the unveilength range 3100 A to 5100 Å at a Sportfal resolution of 1.7 Å. This sagned of the appartment was found to be rich in stock end notocular features. The vibrational and rolational structure of the molecular nitrogen bends provides extraonly valuable information on the velocity of the precipitating particles. From a comparison of the by vibrational and rotal lonal structure, which are alrought populated at the higher levels, and similar data for the 85 bands, we conclude that the event indicate pracipitation of ring current energetic leavy atoms. Because of the absence of observable H₂ emission and because of the theracteries it emergy liferered from the velocity, the energetic atoms are probably oxygon.

J. Coophys. San., A, Paper thd2f

SID MAYA propagation
ELF AND VIF RADIATION PRON THE 'FOLAR RLECTROIST ANTHOMA'

8. Bart | Har-Planck-Institut | for Aeronomie, 8-1411
Retisoburg-Lindao 5, P.R. Carmanyl, 7. Stubba
An approximate svaluation is under of the ELF/VLF
dipole moments of the poles electrojet entenne which is
eatchlished by (conspheric hosting value powerful HP
veves, multivide moduleced with frequencies in the ELF/
VLF range. The theory of raciprocity is then used to
determine the tampolizeds of the ELF/VLF usvaguide excleation produced by such a dipole impared in the longsphere. Propagation under a series of ionospheres ranging from quiet survers injustions to discurbed surversi
daytims is cosmidered. One of the lindings of this luvertigation is that the heavily attenuated veveguida
modes have the bighest arcitation efficiencies. Thus at
distances close to the hancing source, the efficiently
excited heavily attenuated sodes provide the dominant
contribution to the received signal, while the more
weakly axcited modes of low attenuation become declinant
as the propagation range increases. (lonespheric modias the propagation range increases. (loncepheric modification, ELP/VLP waves, waveguide propagation),

\$599 Goneral (Plasma fostabilities) ONLINEAR THEORY OF THE ENR ISSTALLLITY WITH AN NHOMOGENEOUS ELECTRIC PLELS - Yeakinen iNevel Research Laboratory, Weshington,

M.J. Yashinsa (Naval Research Laboratory, Washington, b.C. 1015)

Using analytical and numerical techniques, the nonlinear evolution of the EdD instability with an inhomogeneous electric field has been studied. For the case where the electric field component parallel to the density gradient is inhomogeneous, we find the inhomogeneous, we find the inhomogeneous, we find the inhomogeneous PaB instability in the nonlinear regime (1) evolves into large scale emissionopic finger-like structures, 12: can be described by power law spatial power spectra both parallel and perpendicular to the initial density gradient in which the initial density gradient in which the initial density gradient in working a limite amplitude wave spectrum. Application is made to plants density fluctuations in the sureral iomosphere but the result are also applicable to glassa jet and attriction formation in artificiality produced iomospheric plants clouds. (plasma mecroingishtitles, high latitude iomosphere).

MEASUPERBAYS OF L-PROCON FONLATION AND CONQUCTIVITY PRODUCTS BY SOLAR ILLUMINATION AT HIRS BETTYDOTS R. M. Robinson (SBI International, Radio Physics Laboratory, Menio Park, California, 94025), P. R. Vondrah Flectron density measurements made by the Chatania radar during times when auroral particle precipitation was absent have been used to designment the variation of eragion ionization and height-integrated tonospheric conductivity as a function of solar zentth angle and solar flux. From the Chatania radar data taken over an online solar cycle, we have derived the electron density as a function of altitude between 90 and 250 km for five solar senith angles between 45° and 55° and for four different levels of solar flux. From the OA) prolition were averaged together to determine the mean values; typically the standard deviations were less than 25 particular of the mean. The height-integrated conductivities computed from these profiles increase by about a factor of two between the lowest and highest levels of solar flux. The solar contribution to the Hall and Padersen conductances, by and E_T, is well represented by E_T = 1.5 to constitutions to the Hall and Padersen conductances, by and E_T, is well represented by E_T = 1.5 to conductances, by and E_T is where x is the solar senith angle and S_T is the 10.7 cm solar flux. In order to determine the total conductance when other ionization sources are present, the altitude-dependent production rate is required. This was computed from the data using an altitude-dependent account of the effective recombination coefficient. Conductivity, phecolonization .

Particles and Fields—

Find dain. The twent board some board of the property of agendary as a propried both here and nordier. A detection codel including orbit-Yearer internation geometry, the above scallocad threshold, and Folson statistics has been capitically verified. (Equatorial sposed 7, equatorial posed 7, equatorial pos

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MACHICAGENERAL
O. O. Barboom (institute of Goophysics and Finnetery
Physics, DCLA, Los degales, CA 90024). A. Evister,
U. t. Sincos
A theoretical model and analysis of the occalenation
of bigh-energy. Manyone loss in Jupiter's migratosphere in presented. All measurements conducted in this
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per control of high single populate the observed

then consider the stochastic acceleration of this mood population by magnesohydrodynamic waves. It is dominated that have been proporties of the observed particle apactrum are relaised to those of the power spectrum of MSD fluctuations conserved by the magnetoeser. Tuplier, magnetoephere, ion accelerations.

J. Coophys. Res., A. Paper And255

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COGGELATEO DYEARLOAL CHANGES IN THE REAR-EARTS AND
DISTART HACKLOTALL REGIONS: 1987-7
O. R. Gabor | University of California, Law Alsons
National Laborstory, Los Alsons, JM 87453, S. J. Barv.
a. D. Sellan, W. C. Feldman, J. T. Cosling, P. R.
Rigble, E. U. Honos, Jr., h. J. HcComen, and R. D.
Zuichi

a. D. Sellan, W. C. Feldman, J. T. Conling, P. B. Sigble, E. U. Honos, Jr., h. J. McComen, and R. D. Zwithi
During fetcher 1982 and January-Harch 1981, 1988—fead its first traversals of the distant ir - bh-198 a) geomagnetic isl. Throughout this period the Los Alsaca 1888—I plasma electron instrument detected the tailward cagnetoshoath, mathetapause, plasma sheet, and islitobes. For the control of the tailward cagnetoshoath, mathetapause, plasma sheet, and islitobes. For the control of the saver as all labers. For the control of the saver and tail traversal period nearly continuous concurrent dais were assitable from Lon Alamos Chargod-Particle Analyser (Cyal Instruments on-board he space-raft 1917-07), 1981-823, and 1982-014 at geostationary orbit (b.6 s.l. Using these geostationary orbit (b.6 s.l. Using these geostationary orbit (b.6 s.l. Using these detected, slicking substorm onted detectalsions to accuration of a few churdes. Geomarkely high degrees of correlation between near-warth substorm swonts and issertitans of a few churdes. Geomarkely high degrees of correlation between near-warth substorm swonts and issertitans for one magnetotal listen registe to smother were often found throughout the tail crossing. Particularly not slid were periods of "sallities" engages to smother were often found throughout the tail crossing fleid strucking at 6.6 kg isubstorm growth phases and diametrical espassions of the distant tail seen by 1878-1. Similarly, substore expansion anneals seen at h.b kg were followed by rapid apparent contractions of the iransituar lait which took 182E-f into magnetoshus all substorm particle injection events at 8.6 kg prucede the occurrunce of strong tailward plasma lide by 13 the distant all model of the substorm growth phase and lor substorm initial under oil the substorm growth phase and lor challening tail model of the substorm growth phase and lor substorm initial ton in the near-warth magnetosal register in the control of the substorm growth phase and Lor challening tail model of the

5755 Plasma los abilitles A COMPUTHE SIMULATION SIBUY OF HOUS-INDUCED ELECTRO-STATIC BURSTE UBSERTED IN THE HALMETOSPHERE BY THE ISEE SATELITH B. Mais wood of Padio Almospharic Science Conter, Kyata University, U)1, Kyoto bil, Japani, M. Obashi, and T Onure
Observations from the light solution have taxently
Observations from the light solution have taxently

Observe ions from the 15kt saidlife have tecently revealed interesting electrostatic burgis which are apparently both-induced emissions grimulated by the combined action of a coherent whistlor-tode wave and a simultaneously observed electron been with an energy range of the vicential section of a coherent of the vicential section section. It is not to seek a plausible generation mechanism and interpret this contineer phenomone, a computer simulation study was carried out. The code used is a two and half dimension electromagnetic Particle Code (ENZ code) following mealinest motions of care than a half million perperticles to the 128 = 128 grid speceudar in self-consistent lights. The results show an interesting two-beam justing due to a trapping and subsequent detrapping process, Tolding a mirrog olectrosistic education with two-tor particle in the sternal magnetic field. The monitoest evolutions of the wave spectra and objection are discussed in connection with the observed 65 bursts. [Coopular signistion, electrosistic bursts, chorus hook, nonlinear particle trapping.

reppingl. J. Goophys. Pes., A. Papor NACO26

1755 Places Instabilities
A NOTE ON THE SOUTHWOOD'S INSTABILITY CRITERION

A NOTE ON THE SOUTHNOUN'S INSTAURILITY CRITERION
C. Descri dapplied Mathematics Deportment, Indian
Inefifets of Science, Bengaiore, 560018)
If is about that Santhward's Instability articular
for the ames of Science Hermite Instability of the
megratepass came be directly ablaimed from the margimel featability aendities for the perc Aifres surface
waves propagating along the interface between two
laccompressible media in the limit when the wave
propagating along the lamenty commendicator to the lacompressible madia in the limit when the drive prepagation direction is marriy perpadicalar to the direction of the largest magnetic field. The phose valuedity of the surface waves first smalled at the caset of the fostability depends on the angle batware the laterplacefory magnetic field and first valuedity in the sairs wied to fromf of the box shark. (Mefvir-Beinkeitz inslabifity, magnetophuse, instability splitting, surface waves), J. Moophys, Bes., A, Paper (AR)9)

3760 Yiasas mellon, convection, or circulation LONG(TOD(RAL ASTRACTRY OF THE 10 PLASMA TORUS A. F. Cheng, R. T. Paccessa (Applied Physics Laboratory, The Johns Hoptism Cintwresty, Laurel, HD 10707), Y. G. Mecisson, t. J. Lanseroiti and T. F.

a: Laboratory, The Johns hope the university, Lawre, my 10707), 7. 6. Recisions, t. J. Lanseroit and T. 7. Arasirons.

A clear inbound-outbound asymmetry is found in Toyager 1 toe Energy Charged Particle (1877) phass space densities near 6 Mg. The asymmetry is of the same sign and comparable cognitude for electrons and ions at saward different energias. Eco phase space density yrefiles at three relues of the first invariant are uniforally displaced to larger radius by ~ 0.75 sg during the inbound pass. Inboond-outbound asposities which are very similar for electrons and ions at many different energies con be accounted for naturally by a souvection electric field in the please lores. If the asymmetry is attributed to a convection field fixed in local lies, then the field base component of ~ A style pointing toward oil 30° 17, roughly orthogonal to the described toward oil 30° 17, roughly orthogonal to the described toward oil 10° 10° 1 mg. The country of the corrotating sowerion Yield, such that please ontylon occurs within 170° ct. C 300° at a velocity of ~ 3 x 10° A g s search of the constant with the magnetic momenty could be a proposition of the elfect, then the lone loss rets was ~ 535 greater during the lubound pass.

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